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.

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On Sommerfeld's Surface Wave

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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 $Ru\rightarrow0$ 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.

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On the Transport of Aluminum Atoms by a Gas

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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 these experiments) passes through this window. The largest percentage of the activity seems to come from the window since the substitution of a thin copper window reduces the negatron activity attributable to Al^{28} to negligible quantities. Aluminum atoms appear to enter the system's circulating gas as recoils ejected from the duraluminum by the cyclotron beam. So long as the duraluminum window is used, the existence of helium, nitrogen, oxygen, or carbon dioxide as the system's gas results in identical negatron spectra indicating that the source of the negatrons is in no way connected with the gas which is being circulated.

The method of transport of the aluminum atoms between the bombardment chamber and the spectrometer is still in doubt. It has been suggested that they may be carried on very small dust particles which act as a colloidal suspension in the circulated gas and which are too small to be removed from the gas by the filters used in the line.

The fact that no 5-min. Cu^{66} is present when a copper window is used in the cyclotron may mean that the transport phenomenon is characteristic of aluminum. Windows made from other elements have not been used as yet. However, a study of such effects for several types of windows is planned.

The work is continuing and further details will be published at a later date.

* Assisted by the joint program of the ONR and AEC.

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The Structure and Chemical Composition of Mars

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THE radius of Mars usually quoted[1] is 0.532 times that of the earth. The measured values of this quantity since Hartwig[2] have agreed rather closely with this value. Wright and Trumpler[3] showed that Mars has a substantial atmosphere by photographing the planet in infra-red, yellow, violet, and ultraviolet light, and the latter determined what he believed to be the radius of the planet's surface from the movement of the marking on its surface. His value for this radius is 0.521. The mass has recently been determined by Rabe[4] from the perturbations of the orbit of Eros. His value for the mass is 0.1069 times the earth's mass. Struve[5] deduced the oblateness of Mars from the orbital constants of the satellites and secured 1/190.4, which corrected for the smaller radii became 1/192. Thus, the ratio of the oblateness, ϵ, to the ratio of centrifugal to gravitational forces at the equator, Φ, can be calculated. The value using the larger radius is 1.13 and using the smaller radius is 1.21. The latter value is close to the value for a planet of uniform density, namely, 1.25.

The value of ϵ/Φ can be calculated for a planet of known or assumed density distribution.[6] From Bullen's[7] values for the density of the earth as a function of pressure one finds that

$$\rho=\rho_0+2.05\times10^{-12}p,$$

where ρ_0 depends on composition, and the coefficient of the pressure term is insensitive to composition.[8] The pressure within a planet of uniform density is, $p=(4\pi/6)G\rho_m^2(a^2-r^2)$, where G is the gravitational constant, ρ_m is the mean density, a is the radius of the planet, and r is the distance from the center. Substitution of this for the pressure gives ρ as a function of r. The expression for the mass is easily written down and determines ρ_0 as 3.96. The moment of inertia is 0.394 Ma^2 and it is now possible to calculate ϵ/Φ by well-known relations. The result using Trumpler's radius is 1.22. Brown[9] has calculated this quantity for a model of Mars with an iron core similar to that of the earth and found ϵ/Φ to be equal to 1.02, as compared with an observed value of 1.14, using the usually accepted value of the radius and older mass value. He concluded that the silicate and iron phases are not so completely separated as are those of the earth. Trumpler's smaller and more probable value for the radius thus indicates that Mars is a planet of grossly uniform composition and its density at zero pressure indicates that it contains about 30 percent of iron-nickel phase.

This calculation substantiates the suggestion made by the writer[10] that the primitive earth was composed of a grossly uniform mixture of iron-nickel metallic and silicate phases. The earth's core has grown during geological time and that of Mars has not. The difference is probably due to the difference in initial temperatures. That of the earth was high enough to permit convection currents which generated heat and melted its iron, which then flowed to the core, while the temperature of Mars was too low and it remains a fossil planet furnishing evidence in regard to the earth's past history. This as well as other evidence for this conclusion will be presented in greater detail elsewhere.

Trumpler's value for the oblateness, namely $0.0108(=1/93)$ determined from the measurements of the polar and equatorial diameters and also from observations on the movement of points on the surface agrees with other similar observations but not with Struve's value derived from the motions of the moons. He suggests that some atmospheric effects are responsible for the difference. If the equatorial regions are mountainous relative to the polar regions, the observations could be reconciled with Struve's value, since the moons would recognize the mean oblate spheroid only and Trumpler may have selected mountain tops as his point and the observed disk would be determined by mountains. Again, if the density is not spherically symmetrical and, say, higher in the polar regions and isostatic equilibrium has been attained, the non-rotating planet would be oblate but the moons would not recognize this oblateness. They would recognize only the oblateness due to rotation. A variation of 0.5 percent in the density would account for the disagreement. The atmospheric pressure at the polar surface would be twice that at the equatorial surface, but this probably would not be in disagreement with observation. A combination of these two effects is also possible and both might be caused by some spherically non-symmetrical character of the accumulation process that produced the planet. It appears to the writer that Struve's value is the correct one for the calculations reported here.

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Spectroscopic Value of the Magnetic Moment of $_{83}Bi^{209}$

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PREVIOUSLY quoted values of the nuclear magnetic moment of Bi^{209} have been derived from hyperfine structure separations of only a few levels. The derivations have included an approximate Fermi-Segrè correction,[1] but no correction for the finite size of the nucleus.[2] Hyperfine structures in many lines of Bi II, III, IV, and V, excited in an electrodeless discharge, have been measured in this laboratory by Richmond[3] using a 21-ft. concave grating. From the separations of 14 levels of Bi III, IV, and V the nuclear magnetic moment has been calculated by the Goudsmit formula.[4] When the Fermi-Segrè correction evaluated by the