between k and αk, then ν_k can be written as

$$\nu_k = \kappa \int_{\alpha k}^{\infty} [F(k)]^{\frac{1}{3}} k^{-\frac{1}{3}} dk;$$

or, in the approximate forms:

$$\nu_k \cong \kappa [\alpha(k)]^{-4/3} \int_k^{\infty} [F(k)]^{\frac{1}{3}} k^{-\frac{1}{3}} dk \quad \text{for} \quad k_0 \ll k \ll k_s \qquad (8a)$$

$$\nu_k \cong \kappa [\alpha(k)]^{-4} \int_k^{\infty} [F(k)]^{\frac{1}{3}} k^{-1} dk \quad \text{for} \quad k \gg k_s. \qquad (8b)$$

The further assumption that α is a numerical constant will lead one to suppose that in the comparison made by Heisenberg, (8a) is appropriate, while for our present comparison based on S (8b) will be more appropriate. Thus

$$\kappa \alpha^{-4} \cong 0.26 \quad \text{and} \quad \kappa \alpha^{-4/3} \cong 0.85. \qquad (9)$$

The corresponding values of κ and α are 1.5 and 1.6 approximately.

The author is much indebted to Professor S. Chandrasekhar for many invaluable discussions.

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Radioactivity in Platinum by Neutron Capture*

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THE stable isotopes of platinum, shown in Fig. 1, will by neutron capture produce radioactive atoms of mass 193, 197, and 199. Previous studies[1] have assigned half-lives of 4.33 days, 18 hr., and 31 min., respectively, to these activities. Specimens of supposedly chemically pure platinum irradiated in the Oak Ridge and Argonne piles yield a complex decay curve as shown in Fig. 2. This curve resolves quite completely into three components, as shown, whose half-lives are 82 days, 3.4 days, and 17.4 hr.

The 82-day activity previously unreported, is found by absorption in aluminum to have beta-radiation with an upper limit of about 0.54 Mev and by absorption in lead, a gamma-ray of energy about 0.6 Mev. That the activity is in platinum was shown by a chemical separation. This emitter is thus isomeric with one of the previously reported radioactive isotopes of mass 197 or 199 probably the former.

Exposures in beta-spectrometers under varying conditions showed that the radioactive platinum emitted more than 20 electron lines, whose energies are shown in Table I. The K–L–M differences, where observable, are in every case characteristic of mercury, and the activity producing the lines decayed with the half-life of 3.4 days. It is thus clear that this activity is due to radioactive gold 199, derived from platinum 199, whose half-life is 31 min., and is formed by neutron capture in platinum 198. The suggested interpretation of each electron line is shown in column 2 of Table I and a summary of the gamma-rays in the final mercury 199 nucleus is given in Table II. The K/L ratio can be roughly estimated from the relative line blackness and is approximately unity for lines arbitrarily numbered 4 and 9 and is much less than unity, indicating a high degree of forbiddenness, for lines 5, 6, and 8.

TABLE I. Electron energies from radioactive platinum.

Electron energy kev		Interpretation	Energy sum kev	Electron energy kev		Interpretation	Energy sum kev
20.4		K^4	103.3	114.8		$L_{1,2}{}^5$	129.3
45.9		K^5	128.8	117.0		$L_3{}^5$	129.2
48.5		K^6	131.4	—	or	$L_{1,2}{}^6$	131.5
50.7		$L_{1,2}{}^1$	65.2	119.2		$L_3{}^6$	131.4
—	or	K^7	133.6	—	or	$L_{1,2}{}^7$	133.7
52.4		$L_3{}^1$	64.6	124.0		$L_{1,2}{}^8$	138.5
56.2		K^8	139.1	125.8		M^5	129.4
62.4		$L_{1,2}{}^2$	76.9	—	or	$L_3{}^8$	138.0
64.3		$L_3{}^2$	76.5	128.0		N^5	128.8
74.7		K^9	157.6	—	or	M^6	131.6
84.2		$L_{1,2}{}^3$	98.7	143.0		$L_{1,2}{}^9$	157.5
88.0		$L_{1,2}{}^4$	102.5	145.0		$L_3{}^9$	157.2
94.5		M^3	98.1	154.1		M^9	157.7
				156.2		N^9	157.0

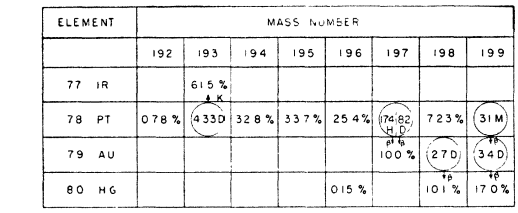

FIG. 1. Isotopic distribution in platinum and neighboring elements.

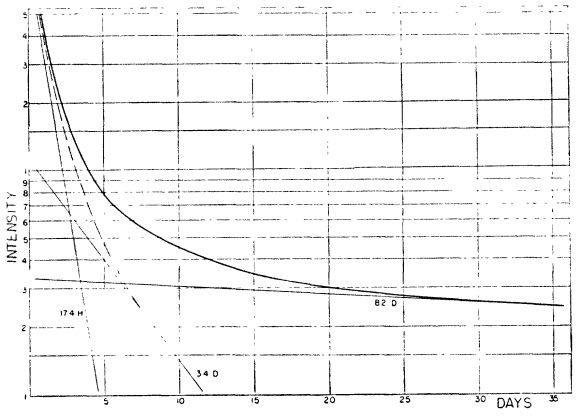

FIG. 2. The decay of activated platinum.

Since the exposure in the pile was of 2 mo. duration, the long-lived emitters were relatively strong compared with the 17.4-hr. activity. It was noted, however, by absorption in aluminum and in lead that beta-radiation whose upper energy was about 0.8 Mev and a gamma-ray of energy 2.2 Mev were present in the freshly irradiated specimen and died out rapidly. No electron conversion lines associated with this short-lived activity could be observed. The radioactive isotopes believed to exist are shown in Fig. 1.

TABLE II. Summary of gamma-energies in mercury 198.

Arbitrary designation	Energy kev	Arbitrary designation	Energy kev
1	65.0	6	131.4
2	76.6	7	133.7
3	98.3	8	138.6
4	103.0	9	157.6
5	129.2		

* This investigation was made possible by the support of the AEC and ONR.
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An Improvement Effect of the Plateau in Xylene- and Argon-Filled Geiger Counters

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AN improvement effect of the plateau by rest has been observed in a counter tube consisting of a wire between two parallel copper-coated steel plates and filled with a xylene and argon

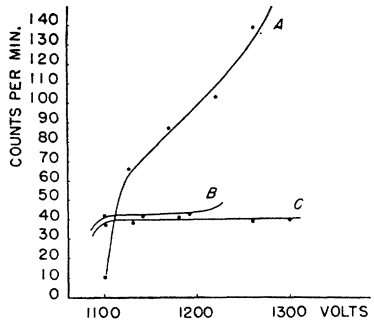

FIG. 1. Effect of rest on the plateau.

admixture near the saturation conditions of the xylene vapor. The tube, used in former experiments, was evacuated and baked at 400°C, then refilled by a xylene and argon mixture at 76 cm of mercury pressure, admitting first the xylene vapor under a pressure of 9 mm Hg. All the following tests were made on the tube sealed to a manifold. After the filling, a rest of 42 hr. was allowed and the tube was then tested. The plateau was found very unsatisfactory, as is seen in curve A of Fig. 1. After a rest period of several days the tube was tested again. The characteristic plateau curves B (after a rest of 216 hr.) and C (at the end of a total rest of 336 hr. after the filling) show an improvement of the plateau by rest.

This improvement was believed to be due to the formation of a continuous xylene film on the cathode. Indeed, for the production of good counters, beside a proper filling, the importance of formation of a suitable surface layer which prevents spontaneous discharges and electron escape from the cathode was pointed out by Trost.[1] The important role of a surface film formation in xylene-argon counters has been emphasized more recently.[2] In order to see the effect of the partial removal of this film, the tube was heated at 120°C (below the boiling point of xylene) for 10 min. and left in the oven to cool slowly, all other parts of the manifold being held at room temperature. At 40°C the plateau showed a high slope (Fig. 2, curve B). The tube was then brought to room temperature and the plateau tested 6 hr. later (Fig. 2, curve C). After 28 hr. of rest, curve D was obtained, which still shows many spurious counts toward the end of the plateau. Finally, at the end of a total rest of 76 hr. after the heating of the tube the plateau E was found to be almost the same as the initial characteristic curve (A, Fig. 2). This recovery of the plateau presents some analogy with the recovery effect observed

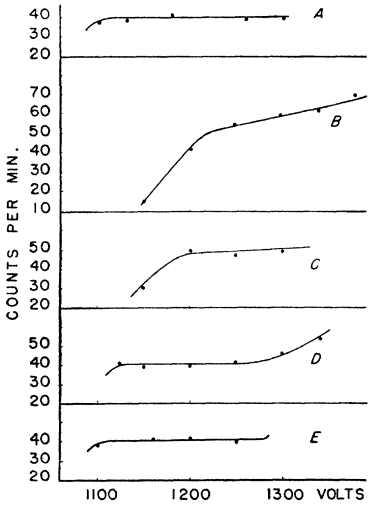

FIG. 2. Effect of film removal on the plateau.

first by Spatz in exposed alcohol- and argon-filled counters.[3] Observation of this improvement effect in a counter filled with saturated xylene vapor, and on the other hand, the absence of a recovery effect in the case of methane-argon-filled counters[3] seem to agree with the suggestions concerning the important role of a film formation on the cathode. The higher threshold voltages of characteristic curves B, C, and D in Fig. 2 show that there is a greater amount of vapor between the electrodes; in other words, according to this picture, the film formation on the plates is not complete. Furthermore, curves C and D being obtained at room temperature, the observed alteration of the plateau in curves B, C, and D would be interpreted as an alteration effect of the film rather than as a temperature effect reported by various observers.[4]

The writer is much indebted to Professor H. V. Neher who first suggested the importance of a possible film formation on the electrodes, and to whom he wishes to express here his deepest gratitude and thanks for an invaluable guidance.

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On Two-Component Wave Equations

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IN two recent letters Jehle[1] and Kilmister[2] have drawn attention to two-component wave equations. The object of this note is to show that such equations can be regarded as degenerate cases of the general wave equation. Jehle's field free equation is equivalent to Conway's[3] form of Dirac's equation when the wave quaternion reduces to its real part, i.e., when it is self-charge conjugate. Hence Jehle's field does not represent an electromagnetic interaction, but, as Serpe[4] has shown corresponds to a pseudo-vector interaction. The equation proposed by Kilmister can be derived from a different quaternion formulation of the wave equation due to Watson[5] when the wave function is invariant under a time reflection. Thus Kilmister's equation has solutions depending only on the space coordinates and it is equivalent to two equations of Jehle's type which differ from each other by the sign of their time coordinates.

Dirac's equation can be written in the form

$$\beta^\nu\partial_\nu\Psi=\mu\Psi, \quad (\beta^\lambda\beta^\nu+\beta^\nu\beta^\lambda=-2g^{\lambda\nu}), \tag{1}$$

where $\partial_\nu=\partial/\partial x^\nu$, $(\nu=0, 1, 2, 3)$ and $x^0=ct$. If Ψ is taken as a complex quaternion, one form of Conway's equation is obtained by replacing β^ν by the linear functions

$$\beta^0\Psi=\Psi f^2, \quad \beta^n\Psi=f^n\Psi f^3, \quad (n=1, 2, 3), \tag{2}$$

where f^n is the nth quaternion unit. As such linear quaternion functions can be represented by 4×4 real matrices and the general equation can be obtained by introducing the field A_ν through the substitution $\hbar\partial_\nu\rightarrow\hbar\partial_\nu+ieA_\nu$, the complex conjugate of Ψ is also its charge conjugate. Hence the self-conjugate solutions of (1) satisfy the real quaternion equation

$$\partial_0\Phi f^2+f^n\partial_n\Phi f^3=\mu\Phi, \tag{3}$$

where $\Phi=\phi_0+f^n\phi_n$ is a real quaternion. Therefore we can rewrite (3) as a complex 2×2 matrix equation by taking

$$f^1=\begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix}, \quad f^2=\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}, \quad f^3=\begin{bmatrix} 0 & -i \\ -i & 0 \end{bmatrix}.$$

Φ being now represented by a complex 2×2 matrix we have

$$\Phi^*=-f^2\Phi f^2, \tag{4}$$

where Φ^* denotes the complex conjugate of the matrix Φ. Hence, operating with $-f^2(\ )f^2$ on (3) we get

$$f^2\partial_0\Phi-f^3\partial_1\Phi f^1-\partial_2\Phi f^1-f^1\partial_3\Phi f^1=\mu\Phi^*. \tag{5}$$