

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

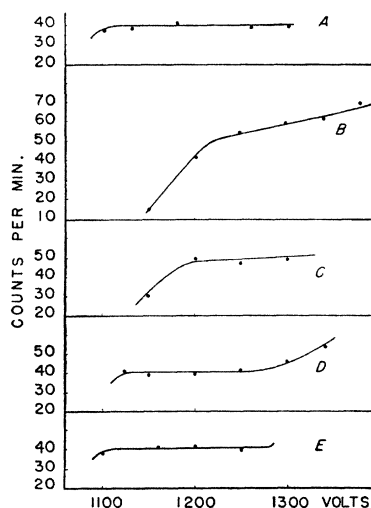


FIG. 2. Effect of film removal on the plateau.

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 counters⁴ 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 Jehle¹ and Kilmister² 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's³ 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 Serpe⁴ 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 Watson⁵ 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

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

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

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

where f^n is the n th 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 $\hbar \partial_\nu \rightarrow \hbar \partial_\nu + ie A_\nu$, the complex conjugate of Ψ is also its charge conjugate. Hence the self-conjugate solutions of (1) satisfy the real quaternion equation

$$\partial_0 \Phi f^2 + f^n \partial_n \Phi f^3 = \mu \Phi, \quad (3)$$

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

$$\Phi^* = -f^2 \Phi f^2, \quad (4)$$

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

$$f^2 \partial_0 \Phi - f^3 \partial_1 \Phi f^1 - \partial_2 \Phi f^1 - f^1 \partial_3 \Phi f^1 = \mu \Phi^*. \quad (5)$$

If γ^ν denotes the matrix operating on the first column ϕ of Φ and corresponds to the linear quaternion function associated with ∂_ν in (5), we can replace (5) by the equivalent equation

$$\gamma^\nu \partial_\nu \phi = \mu \phi^*.$$

As $\gamma^\nu \phi$ corresponds to $(\beta^\nu \Phi)^*$ in the 2×2 representation it follows from (1) that the matrices γ^ν satisfy Jehle's commutation relations

$$\gamma^{*\lambda} \gamma^\nu + \gamma^{*\nu} \gamma^\lambda = -2g^{\lambda\nu}.$$

Further, under a time reflection $x_0 \rightarrow -x_0$ we have $\Phi \rightarrow \Phi_I$, hence $\phi \rightarrow \gamma^2 \phi$.

Kilmister's equation reads

$$(i\partial_0 + f^n \partial_n) \Phi = \mu f^2 \Phi^*,$$

where Φ again is a real quaternion in its 2×2 complex matrix form. By use of Eq. (4) we can write

$$(i\partial_0 + f^n \partial_n) \Phi = \mu \Phi f^2. \quad (6)$$

Operating by $-f^2()f^2$ on (6) then taking the complex conjugate of both sides, we also get

$$(-i\partial_0 + f^n \partial_n) \Phi = \mu \Phi f^2.$$

Hence $\partial_0 \Phi$ vanishes. The two columns of (6) equated separately give rise to a pair of equations of Jehle's type differing by the sign of their first terms only. Equation (6) is related to Watson's form of Dirac's equation which can be put in the form

$$(i\partial_0 + f^n \partial_n) \Psi = \mu \Psi^* f^2$$

where a 4×4 real representation is used for each f^n . This corresponds to the following "realization" of the operators β by linear quaternion functions

$$\beta^0 \Psi = i \Psi^* f^2, \quad \beta^n \Psi = -f^n \Psi^* f^2.$$

In this representation Ψ changes into Ψ^* under a time reflection. Hence the solutions left invariant under $x_0 \rightarrow -x_0$ are given by Kilmister's Eq. (6).

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A Correlation between Ionospheric Phenomena and Surface Pressure*

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RECENTLY, we reported¹ the existence of tidal effects² on the ionospheric F layer. We are now able to show with some degree of reliability that the oscillations in the F layer are approximately in opposite phase to the oscillations of the air at the surface of the earth as measured by the variation in surface barometric pressure. The inverse correlation is evident in the mean curves of Fig. 1.

This is not the first time that an ionospheric characteristic has been correlated with the variations of the surface pressure.³ However, the correlations observed in the past were usually for day to day or hour to hour variations and were seldom verified by investigators in other localities. We believe that attempts at verification were unsuccessful because the real correlation existing is one between the tidal movements at the two levels of the atmosphere. Such a relation between hourly or daily values would often be masked by large local changes due to disturbances other than tidal forces. Thus, if mean values are taken over an interval sufficient to eliminate random daily variations, tidal movements are evident in the mean curves, and the correlation existing between the curves is actually a comparison of the phases of the tidal movements at the two levels. We should expect a relation between the tidal movements at the various levels of the atmosphere to exist since all the tidal movements associated with the

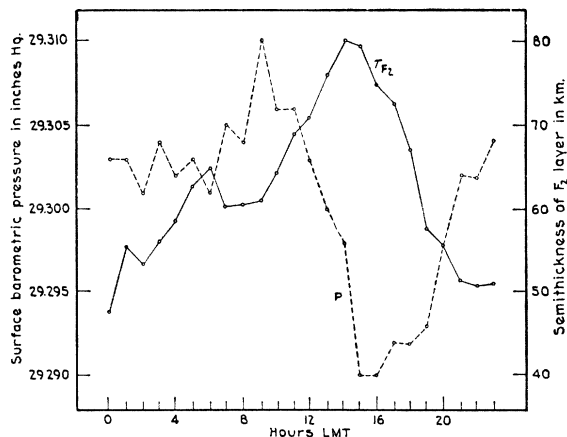


FIG. 1. Mean curves of semithickness τF_2 of the F_2 layer (College) and of surface pressure P (Fairbanks) for October, 1948 through March, 1949.

earth's atmosphere are attributed directly or indirectly to the tide raising forces of the sun and moon.

At College a mean over an interval of 6 months must be used, according to Bartels'⁴ reliability test, to obtain fairly persistent pressure solar diurnal and semidiurnal waves. The same interval is sufficient for similar persistent waves in the oscillations of the semithickness of the F layer.

For further comparison of the tides at the two levels of the atmosphere, the mean variations were submitted to harmonic analyses. The harmonic components of the oscillations relative to solar time are presented in Table I.

TABLE I. Harmonic components of atmospheric oscillations.

	Diurnal component	Semidiurnal component
Surface pressure (amplitude in inches mercury)	$0.0041 \sin(t+14^\circ)$	$0.0036 \sin(2t+124^\circ)$
F layer semithickness (amplitude in kilometers)	$11.5 \sin(t+256^\circ)$	$5.6 \sin(2t+323^\circ)$

We feel that the inverse correlation demonstrated is reliable. The probabilities that the 24 and 12 hour waves in the F layer are due to chance are approximately 10^{-2} and 10^{-1} , respectively, while the probabilities for the corresponding pressure waves are 0.3 and 10^{-2} .

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² The terms, *solar and lunar tides*, used in connection with variations of an ionospheric characteristic simply mean that the oscillations of the ionospheric phenomenon can be shown to be periodic relative to solar and lunar days.

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Coercive Force vs. Temperature in an Alloy with Zero Crystalline Magnetic Anisotropy

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KITTEL,¹ Néel,² and Stoner and Wohlfarth³ have shown that one expects high coercive forces in very fine powders of ferromagnetic materials. This is because each particle acts as a single domain, and work must be done against the total magnetic anisotropy when the magnetization of a particle is reversed, since the dipole moment of the whole particle must be reversed as a unit. The total magnetic anisotropy in general is the sum of contribu-