15297 cm^{-1} since this gives a closer agreement between observed and calculated frequencies when the writer's additions are included. Fowler's term values are used. Takamines' lines are marked with a T.

Of particular interest is the first line (negative ν_{calc}) of this "sharp" series $\lambda = 15300A$ (λ_{vac} Paschen[3]) which is one of the strong lines in the infrared spectrum of Hg. Paschen[4] attempted to use it as the first line of another series but this attempt failed to gain recognition. It does not fit into the once-ionized Hg scheme and appears much too strong in the arc spectrum to be a spark line. Hence this assignment of it to Takamine's series seems quite reasonable.

The deviations from the calculated values are somewhat larger than is desirable but the discrepancies are probably due to the difficulty of accurate wave-length measurements in this region. The intensity[2] (mm deflection) of the first three lines in the "sharp" series and of the second line in the "diffuse" series are particularly convincing as to the correctness of the present assignment. The writer has inserted in the "diffuse" series a line $\lambda_{air} = 9243A$ appearing on Takamine's pictures which he did not include. This line appears as a sharp line on all of Takamine's pictures while most of the others in this series are diffuse or "washy." This must be why Takamine does not include it. However the photographic method undergoes an enormous change in sensitivity between this line and the others in this series, and also the other lines appear much sharper on his one hour exposure than they do on the 10 hour one. It thus seems likely that this line really belongs to the series.

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Eugene, Oregon,
May 31, 1930.

[3] Paschen, Ann. d. Physik **27,** 558 (1907).
[4] Paschen, Ann. d. Physik **29,** 663 (1909).

Boundary Conditions in Wave Mechanics Reply to Criticism

Mr. Eckart's letter in the May 15th issue of the Physical Review about my paper of April 15th on the above subject seems to call for some reply. If the potential varies sufficiently gradually from the constant value zero to a constant value V' then there is no reflexion and if there is no reflexion for a particular wave-length there will be none for any shorter wave-length. My calculation showed that there may be no reflexion at the layers on the surfaces of metals because the thickness of these layers may be sufficient to allow the potential variation to be sufficiently gradual for this when $E > V'$. According to this the usual boundary conditions at a discontinuity may not be applicable to these layers. I therefore suggested new boundary conditions giving no reflexion when $E > V'$ which can therefore be used with these layers when they give no reflexion with $E > V'$. I also suggested that these new boundary conditions may be correct for an actual discontinuity if such a thing can exist.

Mr. Eckart suggests that the absence of reflexion is due to the potential variation acting like an étalon with a spacing of one quarter-wave length. The distance in which the potential changes may be made any multiple or fraction of a wave-length, without reflexion, by suitably changing the constant β so that I do not think the action is really at all analogous to that of an étalon.

I quite agree with what Mr. Eckart says about the very limited generality of the solution of the wave equation which I obtained.

H. A. Wilson

Rice Institute,
Houston, Texas,
June 6, 1930.

Ionization Potential of Carbon

The ionization potential of carbon was estimated as 11.2 volts by Fowler and Selwyn (Proc. Roy. Soc. **A118,** 34, 1928). The basis for this estimation was the C I spectrum which they arranged into series for the first time and a comparison of this spectrum, which was not extensive enough for accuracy, with that of the related spectra of N II and O III.

In my work on the helium continuous spectrum (Phys. Rev. **35,** 1113, 1930) I had noticed that a series of lines shone brightly in the ultraviolet when the stopcock grease contaminated the helium. I followed up this observation by purposely introducing carbon monoxide into the helium with the result that the spectrum of C I has been greatly

extended in the vacuum region and some new features of this spectrum observed. In this note I shall deal only with a small phase of the data now on hand, namely that concerned with the ionization potential of carbon. The fuller treatment is reserved for the complete paper that will be published when the examination of these data is finished.

The most obvious feature of the new ultraviolet spectrum is that it contains three series of multiplets that converge to the same threefold limit, the $^3P_{0,1,2}$ of the atom. These have been measured to eight members and form the basis of the present determination of the ionization potential of normal carbon. The series multiplets are not resolved after the first three members so one has to deal with diffuse lines for the higher terms. Fortunately, however, the middle series is much stronger than the other two. It stands out like a ridge in the mist and is easily measured. It is the middle series that has been used for the calculation of the terms and the ionization potential.

The following is a list of the "ridge" groups: λ1649.93 (2), (uncertain if C I), 1277.53 (5) seen as triplet in second order; 1193.17 (5), 1158.02 (4); 1139.80 (3); 1129.12 (2); 1122.32 (1); and 1117.68 (0). The series limit is $A=90834$ cm^{-1} and the effective quantum numbers for the above lines are 1.905; 2.955; 3.952; 4.948; 5.949; 6.952; 7.955; and 8.970. It is seen that this is very nearly a Rydberg series. The values are not too smoothly arranged but are as good as the nature of these unresolved multiplets when superimposed on two other converging groups might be expected to yield.

Using the known values of the separations of the lowest ^3P term of C I, and assuming that the above limit refers to its center of gravity, the term values have been calculated to be $^3P_2=90817.7$, $^3P_1=90845.2$ and $^3P_0=90860$. The metastable levels ^1D and ^1S listed by Fowler and Selwyn lie 1.179 volts and 2.593 volts respectively above the $^3P_0$ state, and the ionization potential of the carbon atom from the $^3P_0$, lowest normal state, is 11.217 volts.

JOHN J. HOPFIELD
University of California,
May 23, 1930.

The Ultraviolet Light Theory of Aurorae and Magnetic Storms

The ultraviolet light theory of aurorae and magnetic storms[1] contained some unsettled points and some conclusions in disagreement with observation. The further development of the theory of the outer atmosphere[2] and the recognition of an effect hitherto unseen have now automatically removed the discrepancies. So that the theory, with no change in the original assumptions, begins to assume a more finished appearance. The new effect has emerged directly from the results of Page.[3] Page showed, on the assumption of an earth with no excess charge, that the long free path ions in the upper atmosphere would drift westward. We now point out that the westward drift is hindered by collisions of the ions with the neutral molecules of the atmosphere which move approximately with the earth's rotation. As a result of the hindrance there is a displacement of positive ions to polar regions and negative ions to equatorial regions. This sets up an electric field which, together with the earth's magnetic field, causes the high flying ions to move partially with the angular velocity of the earth. They descend into the 50° to 70° latitudes during the evening hours to cause aurorae and the diurnal variation phase of the world wide magnetic storms. With the new values of the electrical conductivity[2] of the upper atmosphere the diurnal variation phase is seen to be due to the gravitational magnetic drift currents set up by the polar ionic concentrations. Agreement is secured throughout with the observations. The second phase of the world wide magnetic storm is found to arise mainly from reactions in the atmosphere rather than to induced currents in the earth.

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Naval Research Laboratory,
Washington, D. C.,
May 28, 1930.

[1] Phys. Rev. **33,** 412 (1929), **34,** 344 (1929).
[2] Phys. Rev. **34,** 1167 (1929), **35,** 240 (1930).
[3] Page, Phys. Rev. **33,** 823 (1929).