seven inches and which occurs in great numbers in the yellow sands around Tuxpam.

There are also casts of a large variety of other forms of bivalves and gasteropods, and as a whole the fauna is later than that of the San Fernando beds and is probably Miocene. We have called these the Tuxpam beds.

The evidence now before us indicates that the upper Tertiary deposits mark a gradually sinking coast line along the gulf border in Texas and Mexico which was arrested in the Tampico-Tuxpam region before it was further north. Thus while early Miocene deposits are on the surface almost at the present water's edge at Tampico and have only a small depth of later deposits overlying them, deposits of the upper Miocene are buried 2,300 feet on Galveston Island and are found in drilling at Saratoga seventy miles inland at a depth of over 1,000 feet.

E. T. Dumble

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

In an address on modern physics before the American Philosophical Society, recently, Professor Ernest Fox Nichols, president of Dartmouth College, said in part:

"I shall try to review very briefly the principal ideas upon which modern physics rests and shall say something about where we think we have arrived in our search for knowledge. I need scarcely remind you that in the natural sciences as in more practical affairs, *how* we have arrived is as important as *where* we have arrived. I shall therefore spend some time in presenting detached fragments of the experimental evidence and inferences upon which certain conclusions are based, hoping in this way to illustrate some of the constructive methods of reasoning employed in research.

"The ideas which underlie all our thinking are space, time and inertia or mass. With space and time as a background, the physicist must pursue inertia and everything related to it, along every conceivable path. In this pursuit he comes upon four ultimate though related conceptions: matter, ether, electricity and energy.

It should be remembered that an important part of our present knowledge of matter, and nearly all that we know of ether and electricity, has been gained not immediately but by inference. In so many cases we see or know directly only the first and last link of a chain of events and must search by indirect means for the mechanism lying between.

"At bottom, I suppose, the ether, electricity, force, energy, molecule, atom, electron, are but the symbols of our groping thoughts, created by an inborn necessity of the human mind which strives to make all things reasonable. In this reasoning from things seen and tangible, to things unseen and intangible, the resources of mathematical analysis are applied to the mental images of the investigator, images often suggested to him by his knowledge of the behavior of material bodies. This process leads first to a working hypothesis, which is then tested in all its conceivable consequences, and any phenomena not already known which it requires for its fulfilment, are sought in the laboratory. By this slow advance a working hypothesis which has satisfied all the demands put upon it gradually becomes a theory which steadily gains in authority as more and more new lines of evidence converge upon it and confirm it.

"As we take up what we believe to be the relations of electricity to matter, we come in places upon slippery ground and the bases of our faith rest on recent foundations.

"At the outset we encounter one striking difference between electricity and matter. Every free charge of electricity exerts a force upon every other charge in the universe, just as every particle of matter exerts a force on every other particle of matter, however distant. But with matter the particles are invariably urged toward each other while electric charges may be either drawn together or forced apart depending on the kinds of charges. We have both positive and negative electricity but only one kind of matter. The bald statements of the laws of gravitation and electric force bear a strong resemblance to each other. The laws tell us how the forces *vary*, but reveal no hint of the machinery by which they *act*. Of the intimate association of electricity with matter we have learned much from careful study of the processes of electric conduction in solutions and gases."

The contributions to our knowledge gained from the recent discoveries of cathode rays, X-rays, spectroscopic studies and the amazing properties of radio-active substances were next discussed and in closing Dr. Nichols said:

"The electron has but a thousandth part of the inertia of the lightest known material atom, and this inertia it doubtless borrows from the kindly ether and does not hold in its own right. Its behavior is that of an atom of negative electricity pure and simple. Its form is spherical and not spheroidal. Its size is probably less than one ten-million-millionth of an inch. When revolving briskly enough in an orbit within the atom it gives us colored light of highest purity. When violently jostling irregularly about it gives us white light, without it all light would be impossible.

"We believe we have found electricity free from matter but never yet matter free from electricity. Finally comes the suggestion that matter no less than life may be undergoing a slow but endless evolution. Some of these things and many others have led physicists to suspect that if all electricity were removed from matter nothing would be left, that the material atom is an electrical structure and nothing more.

"There are, however, many stubborn questions to which answers must somehow be found before the so-called electron theory of matter can be accepted unreservedly. As it stands it is at once a most brilliant and promising hypothesis but has not yet reached the full stature of a theory.

Should it hold good the material atom with its revolving electrons becomes the epitome of the universe. The architecture of the solar system and of the atom, the very great and the very small, reveals the same marvelous plan, the same exquisite workmanship. The conservation of energy becomes an ethereal law and the ether the abiding place of the universal store of energy.

"To end as we began, we have matter and electricity which some day we may know to be one, and ether and energy. Of these we hope some time to build, in theory, a reasonable world to match the one we now so little understand.

"When all the interrelations among matter, ether, electricity are separated out and quantitatively expressed, we believe our work will be complete.

"Such then is the confession of faith, the very far distant hope of the modern physicist."

November 1, 1910

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 687th meeting of the society was held on January 14, 1911, President Day in the chair. Two papers were read:

Discrepancies among Recent Wave-length Determinations: I. G. PRIEST, of the Bureau of Standards.

The speaker, in introducing the subject, reviewed briefly the history of spectroscopic standards, stated that the accuracy at present desired is about 0.001Å., and gave a brief description of the "method of diameters."

In regard to the discrepancies among the results of Fabry and Buisson, Pfund and Eversheim,[1] the following conclusions were presented and supported by tabular data.[2]

1. The difference $(F. \& B.)_{.08} - P_{.08}$ is not markedly systematic when the whole range of the spectrum covered is considered. Considering the precision of the measures, the systematic difference that does appear is perhaps negligible.

2. Throughout the range of the spectrum from 5,167Å. to 6,495Å., inclusive, the difference $(F. \& B.)_{.08} - P_{.08}$ is sensibly systematic, the algebraic mean discrepancy being $+0.0015$Å. Out of the total of twelve differences to be considered in this range, only one is negative, viz., -0.001Å. for $\lambda = 5{,}167$Å., the limit of the range.

3. Throughout the range of the spectrum from 4,282Å. to 5,002Å., the difference $(F. \& B.)_{.08} - P_{.08}$ is not *markedly* systematic, although there is a slight predominance of negative values, the algebraic mean discrepancy being -0.00045Å. Out of the total of eleven differences to be considered, four are positive, five are negative and two are zero.

4. Considering the whole range of the spectrum covered in common by the several investigators, the results of Eversheim appear to be systematically higher than those of Pfund and Fabry and Buisson by about 0.001Å.

5. *The differences,* $(F. \& B.)_{.08} - E_{.09}$ *and* $P_{.08} - E_{.09}$, *when grouped according to sign are also grouped in certain spectral regions as indicated in Table I. In the differences* $P_{.08} - E_{.09}$ *the coincidence of the grouping according to sign and the grouping in spectral regions is pronounced and unmistakable. The spectral grouping of the positive and negative differences* $(F. \& B.)_{.08} - E_{.09}$ *while less pronounced than for the differences* $P_{.08} - E_{.08}$ *is not consistent with this grouping, and the tendency of the groups in the system* $(F. \& B.)_{.08} - E_{.09}$ *to coincide in spectral position with groups of the same sign in the system* $P_{.08} - E_{.09}$ *is decided.*

[1] *Astrophys. Jour.*, **28**, 195; J. H. Univ. Cir., Feb., 1910, pp. 33 and 34; *Ann. der Phy.*, **30**, pp. 837–838.

[2] Initials and subscripts refer to authors and year of publication. See also *Phys. Rev.*, **31**, 602.

Table I[3]

Group	Limits of Group	Number of Lines in Group	Distribution of Differences According to Sign			Algebraic Average of Differences
	(F. & B.)$_{08}$—E.$_{09}$		+	0	—	
I.	4,282 4,593	9	4	3	2	0.0000
II.	4,603 5,083	16	1	1	14	—0.0022
III.	5,110 5,456	10	5	3	2	+0.0016
IV.	5,498 6,495	17	3	5	9	—0.0014
	P.$_{08}$—E.$_{09}$					
I.	4,282 4,494	5	5	0	0	+0.0016
II.	4,860 5,002	5	0	0	5	—0.0020
III.	5,167 5,456	4	3	0	1	+0.0022
IV.	5,498 6,495	8	0	0	8	—0.0038

The large discrepancies existing between Eversheim's determinations in the helium, cadmium and mercury spectra[4] and the earlier results of Rayleigh, Michelson, and Fabry and Perot were mentioned.

As conditions of apparent significance in connection with conclusions 2 and 3 above, the two following facts were emphasized:

1. The line of division between the group of wave-lengths considered in (2) and that considered in (3) is sensibly coincident with the green cadmium reference wave-length.

2. Fabry and Buisson's and Pfund's correction curves for "dispersion of phase" cross each other at about this same wave-length.

As a tentative hypothesis to account for conclusion 4 above, the speaker suggested an insufficient approximation in computing. In support of this hypothesis, he stated that he had recomputed from the published data, the results under II., p. 836, Vol. 30, *Ann. der Physik* (1909), and obtained values systematically lower than the ones there published. These recomputed results were obtained on a ten-place computing machine and so involved no approximation in computation. Computation by seven-place logarithms gave results *systematically* high, while computation by eight-place logs checked the machine results. It happens that the errors of the seven-place table are additive instead of compensating in this case, so that the error in the final result may amount to + 0.002Å. There is a possibility of the approximate logarithmic computation introducing a *systematic* error owing to the fact that all wave-lengths are referred ultimately either to the green or red cadmium wave-lengths as standards; and to the fact that the values of K (see p. 835, Vol. 30, *Ann. der Phys.*) nearly enough equal to fall at the same point in the log table may be expected to frequently occur. As to the importance of this latter condition, nothing can be said without consulting the original data. It seems possible, however, that this condition if it occurs often enough, in connection with the error due to approximation in log λ, may cause a discrepancy about large enough to account for the observed discrepancy between the results of Eversheim and the other investigators.

[3] Data from same sources as mentioned in footnote 1.

[4] *Zs. für wiss. photog.*, 8, 148, March, 1910.

Ocean Currents and Barometric Highs and Lows: Dr. W. J. HUMPHREYS, of the United States Weather Bureau.

In the first part of the paper the speaker dealt with the five barometric highs on the oceans which remain substantially fixed in position throughout the year though varying in intensity, three of which are in the southern, and two in the northern hemisphere. In the second part of the paper the speaker discussed the Aleutian and the Icelandic regions of low barometric pressure.

A brief review was given of the explanations advanced by past investigators to account for the existence and character of these regions of high and low barometric pressure, none of which appeared adequate to account for all of the observed facts.

Lantern slides were exhibited showing the isobars, isotherms and ocean currents over the ocean areas, and the relation of these to the existing high- and low-pressure areas was discussed at some length, the purpose of the paper being to show the physical reasons for the existence of these highs and lows and to explain why they are where they are actually observed to be. (This paper will appear in full in an early number of the Bulletin of the U. S. Weather Bureau.)

R. L. FARIS,
Secretary