which has led to such great changes in our views concerning the theory of cyclones, etc., it is reasonable to suppose that still further investigation in this direction would lead to further advances, and that, therefore, the work is one which deserves encouragement in a practical way. My own plea, which gave rise to this discussion, was for better daily charts. At the present time millions of observations are practically buried so far as the individual meteorologist is concerned. A large part of these could be put on the charts and rendered available for all. My suggestion as to the Daily Weather Charts was, that the *wind provinces* should be put in. I found that, even with the information now published, it was possible to do this with fair accuracy during a period of about ten weeks. With a few more wind observations plotted on the diagrams it would be possible to do this accurately. Then the isotherms and humidities of each wind province could be put on the chart. The isobars run from one wind province to another in continuous curves. This is not the case with the isotherms—they terminate more or less abruptly, as do the humidity curves, at the borders of the wind provinces. The winds and isotherms taken together, therefore, render it possible to draw the wind provinces with some accuracy.

It seems probable that daily charts with all the details that have been enumerated plotted on them would not entail great expense, would very likely teach us a great deal concerning cyclones and anticyclonic areas, and prevent so much valuable detail of atmospheric change being buried on the shelves of our institutions and societies.

R. M. DEELEY.

Abbeyfield, Salisbury Avenue, Harpenden, February 28.

## The Doppler Effect and Carnot's Principle.

So many objections, based on the Doppler effect, have been made to my application of Carnot's principle to each particular frequency in full radiation, that it seems necessary to show that the two methods are not mutually inconsistent.

According to the Doppler effect, when a beam of light $q_1$ per sq. cm. per sec. moving with velocity $c$ is directly reflected by a mirror moving with velocity $nc$ in the same direction, the frequency of every component in the beam is reduced by reflection in the ratio $(1-n)/(1+n)$, which according to Wien's displacement law is also the ratio $T_2/T_1$ of the temperatures of the reflected beam $q_2$ and the incident beam $q_1$. The net expenditure of energy by the radiation per sec. per sq. cm. is $q_1-q_2$, which reduces to $4nq_1/(1+n)^2$, since the energy density varies on reflection as the square of the frequency. Part of this energy $(q_1+q_2)n$, is left in the space $nc$ vacated by the mirror per second. The remainder, $2nq_1(1-n)/(1+n)$, is equal to the work done by the radiation pressure $p$, namely, $pnc$ per sec. per sq. cm. We thus obtain $p=2q_1T_2/cT_1=2q_2T_1/cT_2=2\sqrt{q_1q_2}/c$, which is true for every component separately, and gives in the limit $p=2q/c$ when the motion is slow, and the incident and reflected beams become equal.

The energy left in the medium, $(q_1+q_2)n$, does *not* give rise to a volume of stationary vibration, *unc*, where $u=p=2q/c$, as commonly assumed, because the frequencies of each component before and after reflection are essentially different on account of the Doppler effect. In order to find the stationary vibration, or the intrinsic energy-density $u$ in the state of equilibrium, we must combine each incident ray with a reflected ray of *the same frequency, before* taking the limit. For any component $q$ in the incident beam, the energy-stream of the component having the same frequency in the reflected beam is $q-(dq/dT)_\nu dT$, where $dT=2nT$ when $n$ is small, and $(dq/dT)_\nu$ is the rate of increase with temperature of an energy-stream of constant frequency $\nu$. The net energy supplied of a particular frequency is $2nT(dq/dT)_\nu$ per second, and is equal to $(u+p)nc$. But since $p=2q/c$, this reduces in the limit to exact agreement with Carnot's principle, $T(dp/dT)_\nu=u+p$; which applies correctly to the equilibrium state.

H. L. CALLENDAR.

## Ligament Apparently Unaltered in Eocene Oysters.

DURING the examination of some large specimens of *Ostrea bellovacina*, Lam., from the Woolwich beds, sent on February 20 to this office by Mr. A. G. Davis, of Beckenham, a very interesting case of the preservation of what appears to be organic tissue in an unaltered state has come to light.

The ligament in the two specimens examined has a remarkably fresh appearance, and in its aspect and texture compares so closely with that of a recent oyster as to suggest that the fossil specimen has undergone no change, except that it is somewhat softer and the fibres are less coherent.

The whole of the ligament has been removed from one specimen and preserved in spirit, and a portion will be embedded in paraffin and sections cut for microscopical examination.

The specimens were obtained from the lowest bed of the following section:—

*Excavation for Sewer in the High Street, Beckenham.*

| | | |
|---|---|---|
| | Soil | 3 ft. 0 in. |
| Oldhaven and Blackheath Beds | Buff coloured sand with scattered pebbles<br>Pale grey sand with seams of clay, the lower part ferruginous, with wood and iron pyrites | 9 ft. 0 in. |
| | Cyrena and Ostrea bed with some pebbles | 1 ft. 0 in. to 1 ft. 6 in. |
| Woolwich Beds | Bluish grey clay with broken Cyrena<br>Bluish grey sandy clay with Ostrea | 2 ft. 0 in. |
| | Bluish grey mudstone and muddy sand slightly cemented. Ostrea, Modiola, etc. | Base not cut through |

The preservation of organic tissue in fossils is so extremely rare that this instance is worth recording. Further examination is being made.

R. W. POCOCK.

Geological Survey, Jermyn Street, S.W., March 13.

## Experiments Bearing upon the Origin of Spectra.

IN connection with Prof. Strutt's letter under the above title in NATURE of March 12, it may be of interest to direct attention to some previous work of Prof. Lenard's which contains results bearing on the same subject. Lenard (*Annalen der Physik*, vol. xvii., 1905, p. 197), as a result of a study of the light emission of the electric arc and the Bunsen flame containing metallic salts, showed that the principal and subordinate series are emitted by different distinct regions of the luminous source, and are thus due to different centres of emission. Further, he demonstrated that the centres emitting the different series behave differently in an electric field, and came to the conclusion that while the centres which emit the principal series are neutral metallic atoms (as has been also contended by Wien for the canal rays), the centres of the subordinate series are atoms rendered positive by the loss of one or more electrons, one for the first series, two for the second, and so on. This theory is strikingly borne out by Prof. Strutt's experiments, all of which seem to be explicable by it; in any case, this independent confirmation seems to place beyond doubt the different electrical state of the centres emitting the different series

E. N. DA C. ANDRADE.

University of Manchester, March 13.