Cloud Electric Potential.

UNDER the above heading, in NATURE of July 19 (p. 269), which has just come into my hands, Mr. E. Douglas Archibald criticizes a statement of mine in Part III. of "Deschanel," respecting electrified drops of water in a cloud. The following is the statement:—

"The coalescence of small drops to form large ones, though it increases the electrical density on the surfaces of the drops, does not increase the total quantity, and therefore cannot directly influence the observed potential."

At the word "therefore" I give a reference to a previous section, in which it is shown that the potential at a point is the sum of all the quotients q/r , q denoting an element of the electricity to which the potential is due, and r the distance of this element from the point in question. Since the coalescence of drops is without effect on the value of each q and its corresponding r , it cannot affect any one of the quotients q/r , whose sum constitutes the potential.

Mr. Archibald's criticism is:—

"Surely this entirely omits the fact that the capacity of a sphere is equal to its radius, and thus, in the case of eight equal spheres coalescing into one, not merely would the density be doubled, but the potential of the same quantity would be increased four times."

This criticism rests on two false assumptions:—

First, that the potential of a drop depends on its own charge only, and can therefore be computed by dividing its charge by its radius.

Secondly, that the potential of the drops (which on this supposition would be very different from the potential at a point midway between two drops) can be identified with "the observed potential."

J. D. EVERETT.

Cushendall, Co. Antrim, August 3.

THE ABSORPTION SPECTRA OF CRYSTALS.

ALL who are interested in the difficult work now going forward in so many chemical laboratories, in connection with the nature and constitution of those most complex mixtures known as "rare earths," and who recognize the extremely important influence which the solution of this subject must exert upon the very basis of our modern chemistry, will gladly welcome a new and exquisite means of investigation which M. Becquerel has recently brought to light.

As the reward of a most exhaustive study of the changes which are brought about in a beam of light by its passage through a crystal, M. Becquerel has discovered the key by means of which he is enabled to interpret the subtle indications which the issuing rays afford as to the nature of the molecules among which they have been threading their way. It appears at first sight more than wonderful that these delicate indications can have led to precisely the same weighty conclusions as those arrived at from the renowned physico-chemical researches of Auer von Welsbach, Lecoq de Boisbaudran, Demarçay, Sorêt, Crookes, and Krüss and Nilson. Yet such indeed is the case, and it even appears likely that the new method may be carried still further into the region beyond that which has up to the present been reached by these experimenters.

In order to explain the nature of this discovery, it will be necessary to describe the experimental steps which have led M. Becquerel towards it. In the year 1866 Bunsen found what now appears to be the germ of a great principle—that when a crystal of the sulphate of the substance didymium, now known to be a most complex mixture, was traversed by a beam of plane-polarized light vibrating at an angle of 20° to the horizontal diagonal of the crystal, the absorption spectrum was slightly different from that which was obtained when the ray was polarized in a plane at right angles. This observation did not attract much attention at the time, it being considered merely as a curious manifestation of the phenomenon of pleochroism.

Sorby, however, in 1869 again reopened the question, having found that in zircons the ordinary and extra-

ordinary rays presented different bands of absorption. Since that time Becquerel himself has shown that the same applies to all birefractive crystals which give absorption spectra.

With so much premised, we are now in a position to consider the main results of this more recent investigation. They may be very briefly summarized as follows:—

(1) The bands in the absorption spectra of all crystals have fixed positions: the intensity alone varies with the direction of propagation of the light.

(2) In most crystals, the principal directions of absorption coincide with the directions of optical elasticity.

(3) In certain crystals the directions appear to be very different for different bands, but they always remain subject to the conditions imposed by the crystalline symmetry; thus in monoclinic crystals one of the principal axes of absorption always coincides with the axis of symmetry, and the other two rectangular axes are situated in the plane of symmetry.

Hence it appears to be a fact that the absorption of luminous radiations of fixed wave-length admits of three directions of symmetry. These directions appear generally to coincide with the principal directions of optical elasticity, with the exception of certain remarkable anomalies in particular crystals. Here, however, is the whole gist of the matter. Why these anomalies? Just as from a consideration of the deviations from Boyle's law physicists have learned how to measure the size of those wonderfully minute entities familiar to us as molecules, so has M. Becquerel extracted a most important principle out of the anomalies to the law of absorption in crystals.

It appears probable that absorption may be due to a physical phenomenon dependent upon the intermolecular movements. The intimate relation between phosphorescence and absorption, notably in the compounds of uranium and certain of the rare earths, appears to show that in solids and liquids the radiations absorbed are those which vibrate in unison with the molecular movements. This conception is in fact nothing more than an extension to solids and liquids of the well-verified law of the absorption by incandescent vapours.

As the molecular elasticity varies in different directions in crystals not isotropic—that is, not belonging to the cubic system—so will the absorption vary; and if, in two isomorphous substances, the directions of molecular elasticity do not exactly correspond, the directions of different absorption in the two substances will vary in like manner. Now it is quite true that many crystals of isomorphous substances—that is to say, substances of analogous chemical constitution crystallizing in similar forms—have their optic axes unequally inclined.

If we crystallize two such substances together, in gradually increasing proportions of one of them, we find that the angle between the optic axes in the mixed crystals diminishes progressively until it reaches zero, after which the two axes again diverge in a plane perpendicular to their original plane. Thus can we cause the influence of each in turn to preponderate.

Each chemical substance therefore exerts its own influence, and the molecules retain the optical properties which they manifest when the substance crystallizes alone. Hence the propagation of luminous waves is the resultant of the actions which each of the molecules composing the crystal exerts upon the luminous vibrations. If the directions of absorption do not coincide with the axes of optical elasticity, it indicates the presence of molecules of different substances in the crystal. From these considerations it will be evident that the anomalies are probably due to the coexistence in the same crystal of different matters, geometrically isomorphous, but optically unlike, and which from the absorption point of view behave as if each were alone. The use of the spectroscope will therefore enable us to recognize the individuality of differently