In the light of the aforementioned ideas about solvation, is this treatment free from objection ? On the statistical view of solvation, the solvent shell around an ion cannot be a rigid structure. An individual solvent molecule can leave it and its place be taken by another molecule or perhaps by an oppositely charged ion. Consequently the solvent shell of an ion does not act as an impenetrable barrier to other ions and undissociated molecules of the kind which occur in vapourised strong electrolytes at temperatures such as 2,000° C. can be formed. The size of the solvated ion is not of prime importance. The deciding factors are the free energies of the systems (1) cation and anion solvated to average extent and (2) undissociated molecule, possibly solvated as well. That solvation of an undissociated molecule may be a factor comparable with solvation of an ion can be shown by an approximate calculation for a dipole similar to that of Born for an ion[4].

The larger ionic radius in non-aqueous media often given by Stokes's law[1,5] may be due to the solvent molecules being larger and hence the solvated ion larger, although the energy of solvation may be less than in water and the solvent shell may even contain a smaller number of molecules.

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March 25.

[1] Hartley and Hughes, *Phil. Mag.*, **15**, 610; 1933.
[2] Butler and Shaw, *Proc. Roy. Soc.*, A, **129**, 519; 1930.
[3] Bjerrum, see Falkenhagen, "Elektrolyte", p. 257, Leipzig, 1932.
[4] Martin, *Phil. Mag.*, **8**, 547; 1929.
[5] Davies, "Conductivity of Solutions", p. 183, London, 1930.

Dimensions of Fundamental Units

PROF. CRAMP has proposed[1] that the dimensional expressions for the electrostatic and electromagnetic units may be simplified by regarding quantity of electricity Q as fundamental. To my reply[2], that including Q would cause confusion because, whereas M, L and T are quantities which vary with the velocity of the observer, Q is invariant, Prof. Cramp's[2] rejoinder is the question: How it is known that Q is invariant ? The invariance of the charge carried by a moving particle is, I believe, generally accepted. A simple proof of the consistency of this invariance with the special principle of relativity is given in N. R. Campbell's "Modern Electrical Theory", p. 361.

Prof. Stansfield[3] makes a plea for the simplification introduced by regarding k and μ as mere numerals. I agree with Prof. Stansfield, but in order to make this point of view logical, I think that we must regard 'magnetic pole', m, as a unit derived from 'electric charge', Q, rather than as an independent unit.

The hypothesis tentatively accepted in physics is this, that there are in the physical world two fundamental factors, namely, positive charges ('protons') and negative charges ('electrons'). Each of these is a symmetrical radial field of unlimited extent. The lines of flux of the proton are directed radially outwards, those of the electron radially inwards. The lines possess 'tension' and also 'mass per centimetre', the magnitudes of which agree (in analogy with $v = \sqrt{F/m}$ for the transmission of transverse disturbances along a stretched string) with the fact that transverse disturbances are transmitted along the lines with the velocity, c, of light. Fluxes similarly oriented show mutual lateral repulsion; those oppositely oriented show attraction. Vectorial combination of fluxes permits the resultant forces to be expressed in terms of the tensions in the lines. When electric fluxes are in relative motion, laterally, the 'charges' from which they emanate exert mutual forces on account of this relative motion, namely, the charges are mutually repelled when their laterally approaching fluxes are oppositely oriented, and are mutually attracted when the fluxes are similarly oriented. Experiment shows that the magnitude of these forces depends on the relative lateral velocity of the fluxes.

In empty space the law of force between charges Q and Q^1, at rest, d cm. apart, is $f = Q \times Q^1/d^2$. Usually, however, the space is not empty but contains some medium, that is to say, it contains protons and electrons. These exert forces on Q and Q^1 and the resultant apparent mutual force between Q and Q^1 is not $(Q \times Q^1)/d^2$ but is $(Q \times Q^1)/kd^2$, where k is a *numeral* intended to take account of the 'nature of the medium'.

The force between charges, resulting from relative lateral motion of their fluxes, involves Q, Q^1 and d and, in addition, the velocity of relative lateral motion. This force is called 'magnetic'. Its value, for two moving fluxes due to charges in empty space, involves only Q, Q^1, d and the relative velocity v of lateral motion of the fluxes, but in space which is not empty but contains a medium, the apparent mutual force between Q and Q^1 is due, partly, to the action on the fluxes of Q and Q^1 of the fluxes due to moving protons and electrons in the medium.

A 'unit magnetic pole' is a fictitious thing. There are no known means of producing such a field of flux as a unit pole is imagined to produce. The notion of such a pole is useful, however, because we can produce by means of currents (that is to say, by moving charges) effects (locally) such as poles ought to produce. This means, I think, that we assume the meaning of the equation $f = (m \times m^1)/\mu d^2$ to be the same as that of the equation $f = (Qv \times Q^1v)/\mu d^2$ where μ is a numerical constant taking into account the presence of moving charges within the medium, and v is the relative velocity with which two like charges must move past each other in order that their 'magnetic' repulsion shall equal their 'electrostatic' repulsion. Experiment has shown that this velocity is c, the velocity of light.

If then we write Coulomb's laws, $f = (Q \times Q^1)/kd^2$ for charges and $f = (Qc \times Q^1c)/\mu d^2$ for magnetic poles, we find that the nature of a charge, Q, may be expressed either as $k^{\frac{1}{2}}df^{\frac{1}{2}}$, using the E.S. system of units, or as $\mu^{\frac{1}{2}}df^{\frac{1}{2}}c^{-1}$, using the E.M. system, the ratio of the two expressions being c, the velocity of light.

From this simple point of view, which I think is sound, we must regard both k and μ as mere numerals, and 'pole', m, not as an independent unit but as equivalent to the product $Q \times c$. Always we measure a thing by its effects. Charge has two ways of producing the same effect. A charge Q at distance d from a like charge repels that charge *electrostatically* with force f if the charges are at rest, or *magnetically* with the same force f if the charges have relative lateral motion of c cm. per second.

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[1] NATURE, **130**, 368, Sept. 3, 1932.
[2] NATURE, **130**, 892, Dec. 10, 1932.
[3] NATURE, **131**, 59, Jan. 14, 1933.