liquid helium 1, despite its lower temperature, as Prof. Satterly has himself pointed out elsewhere[1]. It would be interesting to ascertain the absolute cause of this discrepancy.

J. NEWTON FRIEND.

Central Technical College,
Birmingham.
Jan. 28.

[1] *Rev. Mod, Phys.*, **8**, 353 (1936).

Magnetic and Electrical Dimensions

IN NATURE of January 9, in a review of Dr. Lanchester's book on "The Theory of Dimensions", Prof. G. W. O. Howe devotes a portion of his review to the dimensions of electrical entities and his own views upon the same, and criticizes adversely a paper of mine upon this subject, which Dr. Lanchester had printed in full in an appendix in his book.

Prof. Howe proposes to write the fundamental equation of electromagnetism

$$f = \mu \,.\frac{ids}{r^2}\,.\,ids,$$

and he evidently intends μ to be the permeability, because he states: "The classical formula $f = mm'/\mu r^2$ is merely the above formula wrapped in mystery".

It will be noticed that in Ampère's classical equation given above, Prof. Howe has substituted μ for $1/A'$. He does this without any explanation or justification, unless, since $c^2 = A'/K$, it is merely to maintain the expression $c^2 = 1/\mu K$, whereas the full expression is $c^2 = A'/K = A^2/\mu K$, A, A',μ and K being the four fundamental constants in the classical theory. Now Maxwell assumed A' to be an undimensional constant numerically equal to unity, and this has been the established practice, hence K has the dimensions $1/V^2$ and even if $c^2 = 1/\mu K$, μ must be undimensional, a conclusion to which Prof. Howe objects.

With regard to Prof. Howe's mystery and his further reference to "such a fictitious complexity as a permanent magnetic point pole of unit strength", is there any more in this than the conventional application of our standard method of dealing with a system of distributed forces in a case where the forces are both attractive and repulsive, by finding the centroid of each system and calling these points the poles of the magnet? The resultants through the poles give the same magnetic moment as the magnet possesses, and the historical choice of the unit pole was a very natural one. How else would it be possible to deal with the interaction of magnets? It is a common physical laboratory experiment to determine the equivalent poles of a long bar magnet by means of an exploring coil or vibrating needle. Other "fictitious" complexities are found useful in other branches of science in order to make very abstruse problems easily tractable, such as point sources and sinks in hydrodynamics. Think of Rankine's work on streamlines by this method.

If magnetic forces are due to electric currents, then the two standard equations $f = ids\,.\,i'ds'/A'r^2$ and $f = mm'/\mu r^2$ must be co-dimensional, and the simplest solution is $m = iL$ and $A' = \mu$ dimensionally. No objection either physical or mathematical has yet been offered to this solution, which eliminates from electrical science that great bugbear, the dual system of dimensions, and no sacrifice is required in adopting it.

I would remind Prof. Howe that one International Committee has already recommended that μ is to be considered a dimensional entity, also that the final decision is to be made this year.

JAMES B. HENDERSON.

38 Blackheath Park,
London, S.E.3.
Feb. 11.

IN reply to Sir James Henderson, I can only say that I was under the impression that I had given ample explanation and justification for introducing only one magnetic constant of space. If ferromagnetism is due to orbital movement of electrons, that is, to electric currents, then I cannot believe that the forces between magnetic poles involve one property of space and the forces between current-carrying conductors another property. I intended μ to be exactly what I stated in the review, namely, the space constant which makes the formula for the force between electric currents (or magnets) dimensionally and numerically correct, just as $1/K$ is introduced in the formula for the force between charges, and G in the gravitational formula.

I agree that point sources and sinks are excellent mathematical tools and that the unit pole is a very useful conception, but having invented the conception, let us not look to it as an oracle and expect it to answer questions on the ultimate realities of electromagnetism. As I have said elsewhere[1]: "the greatest danger in this subject is that of overlooking the fact that, having put various ingredients into the hopper and turned the handle several times, the result has not dropped from heaven but has come out of the machine and contains all the assumptions that were put in". For this reason I am not impressed by the statement that on certain assumptions "μ must be undimensional" or that the simplest solution of some equations is that $A' = \mu$ dimensionally.

With reference to the equations "$f = ids\,.\,i'ds'/A'r^2$" and "$A' = \mu$ dimensionally", to which Sir James Henderson says "No objection either physical or mathematical has yet been offered", seeing that this is equivalent to writing $f = ids\,.\,i'ds'/\mu r^2$ with μ in the denominator, I can only express my surprise that such a suggestion is put forward seriously.

I cannot understand why Sir James Henderson should remind me of the well-known fact that one International Committee has already recommended that μ is to be considered a dimensional entity. This is surely what I maintained in the review. I was under the impression that he was trying to maintain the contrary opinion. I am in entire agreement with the recommendation of the Committee and with Rücker, who pointed out the advantage of "not suppressing the secondary fundamental units such as μ and K" by "arbitrarily assuming that some one of the quantities involved is an abstract number"

G. W. O. HOWE.

University,
Glasgow.
Feb. 17.

[1] *Wireless Engineer*, January 1937, editorial.

Supraconductivity of Lanthanum

WE have investigated the magnetic behaviour of lanthanum below 10° K. The metal was kindly lent to us by Prof. F. M. Jaeger of Groningen; the analysis was given as lanthanum 98 per cent, iron 1 per cent and traces of carbon, silicon, aluminium

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