The rest of Professor Bell's article can be found in any elementary textbook on electromagnetic theory; its testament, however, does nothing to establish that theory which is in the process of being replaced by a simpler formulation.

D. S. Walton
CAM Consultants
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Reference

1. Bromberg, J. "Maxwell's Electrostatics," *American Journal of Physics*, 36, 145-151 (1968).

The author replies:
First, Dr Walton's reference to Aristotelian philosophers is a red herring. I mentioned early speculation about the planets because Newton's theory of gravitation was based on the hypothesis that the same force accounted for objects "falling" to earth (the notorious apple!) and for planets describing *closed orbits* about the sun. It then involves the conceptual difficulty of action at a distance, unless one prefers to postulate fields of force. Incidentally Newton was *not* the first to suggest that a body in motion would so continue if undisturbed. Hobbes in his book "The Leviathan" mentions that it was a subject of discussion whether this be so or not, and himself unhesitatingly chose Newton's answer. Newton's achievement was to formulate the precise law and "prove" it by incorporating it in his complete system of mechanics which was supported by experimental evidence.

In considering the proposed alternative to Maxwell's theory of electromagnetic waves, there are two questions. First, what is an "energy current"? "Current" usually means flow of something; and "energy" seems to me entirely abstract unless qualified by some adjective such as kinetic, electrostatic etc. So what flows? Second, is there a relation, and if so why, between this "energy current" and the observable electric and magnetic effects? For example, the creation of a spark in air by a focused laser beam is consistent with the electromagnetic theory of light.

As regards the chronology of Maxwell's different uses of displacement current, the main point is that he did find use for it other than in the derivation of a wave equation. Others have since found its use in "electrostatics" convenient or even essential. (See footnote to article.) It may be that the logical train of development which I suggested is a *post hoc* rationalisation, but one cannot prove whether or not this was how Maxwell saw it.

The article by Joan Bromberg is entitled "Maxwell's Electrostatics" and details Maxwell's difficulties in arriving at a satisfactory formulation of 'displacement' in electrostatics, based largely on the concept of polarisation. So it is in agreement with the point which I was making: Maxwell regarded 'displacement' as an essential part of the description of electrical phenomena, not just as a device to facilitate the formulation of a wave equation.

Of course most of the content of my article in the August issue is to be found in standard text books. It was written on the supposition that there are many readers of *Wireless World* who have not studied a text book on electromagnetism.

D. A. Bell

WHAT IS AN ELECTRON?

For the past decade or more I have been saying that mechanical force is that component of electromagnetism which is radiation pressure. Since Professor Jennison (June issue) appears to agree with that concept, at least insofar as the internal forces of a system are concerned, might I be allowed to point out certain errors in the basis of his argument which arise out of the concept itself?

First let me say that I agree to the possibility of the 'phase locked cavity' idea of an electron. It is the basis of the mathematics which is questionable.

Clearly, from his argument, the alteration of motion and kinetic energy of the electron is related to the laboratory in which the experiment is conducted. Within the context we must ask the question – what is kinetic energy? Part of the mathematics is based upon the answer.

Since force is radiation pressure then the source of the radiation is undoubtedly related to the laboratory; the radiation has some specific velocity. Let us consider the Newtonian case; here the maximum velocity is infinite and the effect of the force (the origin of which is with the laboratory) will diminish linearly as F/v, where v is the velocity relative to the laboratory. This is a first order Doppler effect and quite readily understandable.

To cause a change of momentum from 0 to v the force will need to be applied to the mass over some distance L. We therefore have

$$F.L/\tfrac{1}{2}v \qquad (1)$$

to cause a change of motion

$$M.v \qquad (2)$$

thus

$$F.L/\tfrac{1}{2}v = M.v$$

or

$$E = \tfrac{1}{2}M.v^2 \qquad (3)$$

Any explanation which purports to describe inertia in terms of radiation pressure, and at the same time ignores this fact, must surely be ill founded. Where the radiation travels at the velocity c then, due to Doppler, the maximum velocity possible is c and the second order term appears in the form of the Lorentz transform.

In either the Newtonian case or the relativistic case, we may be sure that the energy equations depend upon factors that are *external* to the mass under consideration. The mass increase hypothesis is therefore no longer tenable; special relativity thus fails.

My second objection to the Professor's argument is of a more practical nature. It is known from experience with communication that e.m. waves do not interfere each with the other in empty space. How then is it suddenly possible for those same waves, in a particular configuration, to be affected by similar waves external to that configuration?

We may be quite certain that even though the electron might be a 'phase locked cavity' the boundaries of the cavity comprise material particles.

Alex Jones
Paimpol
France

The author replies:
I can understand Mr Alex Jones being worried that I had apparently forgotten about kinetic energy related to the laboratory. It is quite impossible to cram all the analyses from many scientific papers into one article in *Wireless World*. I can reassure him that, in *J. Phys. A*, 11, 1525-1533, I treated the electron as a phase-locked cavity and rigorously derived the correct relativistic kinetic energy and momentum for the electron scattered in the Compton effect – the first classical explanation of this phenomenon. Contrary to Mr Jones's statement, the result is perfectly consistent with the relativistic increase of mass and there is no question of the failure of special relativity. Mr Jones then wonders how it is that waves which normally propagate without a "photon-photon" interaction in free space should have different properties when locked in a particular configuration. All that I can say to this is "Why not?". The travelling waves have no inertial mass but the treatment shows that standing waves acquire this property and thereby become tangible entities.

Mr Jones's final conclusion "we may be quite certain that even though the electron may be a phase-locked cavity the boundaries of the cavity comprise material particles" does not stand up to a full analysis of the energy distribution of an electron. All that is required is for the wave system to loop on itself under particular circumstances at this particular wavelength. I wonder also of what substance these 'particles' are to be made? It is possible to derive the relationships for inertial force and mass without mentioning the boundaries. Consider a centrally noded $\lambda/2$ standing wave system, of energy E, in which the node is moved to the right. The force from the right is, very closely.,

$$F_R = \frac{E/2}{\lambda/4}(1+v/c)$$

and that from the left is

$$F_L = \frac{E/2}{\lambda/4}(1-v/c) + \delta F$$

where δF is the impressed motive force. The system is in kinematic equilibrium and therefore $F_R = F_L$, hence
$\delta F = 2E/\lambda[(1+v/c)-(1-v/c)] = 4Ev/\lambda c$ but $\lambda/2 = c\delta t$ where δt is the feedback time and, from Galileo, the acceleration is
$a = 2v/\delta t = 4vc/\lambda$
Therefore the impressed motive force

$$\delta F = \frac{E}{c^2}a$$

whence we obtain at the same time

$E = mc^2$ and $\delta F = ma$.

R. C. Jennison

THE MILLIBEL

Mr P. Marks's call in a recent letter (June issue) for recognition of the millibel was very special pleading indeed. This tiny unit is unlikely to find application outside the laboratory, or even inside most such places.

In my current work in acoustics, the uncertainty of accuracy of a precision grade sound level meter will probably exceed ±0.5dB (i.e. ±50mB at a calibration level around 10,000mBp). The overall uncertainty of measurement will far exceed this value, as meter readings fluctuate widely for small changes of reading position other than in free field conditions. Even if the last-mentioned conditions can be established in anechoic chambers, the angular variation of sound radiation is likely to be at least of the dB order for most practical sources. Lastly, it might be thought than in audiometric work such as hearing assessment greater accuracy would be needed. But it is well-known that