

Maxwell's Displacement Current

By Harry H. Ricker III

1.0 Introduction

This paper is in the way of a comment to the paper on displacement current by David Tombe recently published at the GSJ.

2.0 Maxwell's Basic Idea

If one reads the statements by Maxwell regarding the displacement current concept, it is clear that his intention is that his definition of this physical conception is to be a concept equivalent to a conduction current in that it produces a magnetic field just a current or movement of charge does. It seems to this writer that what Maxwell means is that there is a movement of "electricity" in both cases. This is really the heart of the problem, because it is a matter of viewpoint as to what his conception of electricity means. For Maxwell it meant more than just a simple movement of electricity in wires as he saw the need to suppose that this movement participated in the creation of the electrical state of stress of a dielectric substance, and so the idea implied a polarization of the aetheric medium. Maxwell's idea seems to have been to suppose that the movement of electricity within the aetheric medium was equivalent to the movement of electricity in wires.

Now it is important to understand that this conception of the displacement current is the crucial ingredient in understanding Maxwell's electromagnetic theory. For in his view it is the action of the electricity in the aetheric medium that is the cause of the propagation of the electromagnetic wave. Hence in Maxwell's theory it is what happens in the aether that is crucial, and that is where the modern view differs from the Maxwellian approach as expressed by David Tombe's paper.

3.0 The Ampere Law

In his paper, Tombe objects to the addition of displacement current to the conduction current. I think this needs to be clarified. In my opinion, the equation that results is a nice mathematical equation, but it implies something that is not physical. It suggests that we have both a conduction current and a displacement current in the same physical situation. Clearly we don't have a conduction current in the propagation of electromagnetic waves, so we don't have a J term in this case. It does no harm to write in down then set it to zero, as we know there is no conduction current. The same thing occurs in a capacitor, but in this case there is a tendency to try to add the two currents as if they are to be combined physically. I think this is the source of the trouble, since the situation is not a sum of the two currents but a case of either this current, or that current, but not both. The reason is that we are usually either concerned with calculating the magnetic field of a conduction current or the field of a displacement current, but the cases in which we do these calculations are mutually exclusive.

To make this clear. When we use displacement current we are concerned to find the magnetic field in a situation where there is no conduction current, in other words in the space between the plates of a capacitor or in the aether. There are rare times when we desire both but this is simply a calculational puzzle, and not an important and meaningful physical situation.

The point here is that Maxwell says that displacement current is a true current and therefore a source of magnetic field. This interpretation allows us to calculate a magnetic field that arises within the aetheric medium, where no such field should arise, since there is no conduction current in the usual sense of this concept. This is basically the real meaning of displacement current for the Maxwellian viewpoint. The displacement current that arises within the capacitor is another useful case, but it is not the crucial point of Maxwell's theory. That point is the way an electromagnetic wave propagates within the aetheric medium.

4.0 Displacement Current Without The Aether

The banishment of the aetheric medium from physics is the basic point of David Tombe's paper. What effect does this have on the electromagnetic theory of Maxwell? In my view it destroys the entire Maxwellian electromagnetic theory, and I think this is what David was driving at. Without the aetheric medium, the idea of a displacement current is just an absurdity. Its function no longer exists in terms of its meaning in a physical context, so why keep it around? This last question is actually of great importance. We are faced with two alternatives. Keep the aetheric medium and the displacement current, or dispense with the aetheric medium, the current choice, and modify the displacement current conception to accommodate this change. I think the controversial nature of displacement current in physics is the result of the failure of the second choice to do a really good job of replacing the displacement current idea introduced by Maxwell.

The simple fact is that displacement current without aether is a pointless, or more correctly an orphaned concept of physics. It has lost its reason to be in physics, yet physics can not seem to rid itself of this concept. It is an orphaned necessity. That explains its contradictory nature and the persistent disputes about its true meaning. These are of course pointless without bringing back the aetheric medium, which is the entire reason that the concept exists in physics.