Answers to Questions

The following query has been posted by PhysicsProf on overunityresearch.com.

> The long current-carrying solenoid is interesting. The B field is almost entirely contained INSIDE the solenoid, yet the EFFECTS can be felt by a wire-loop (multiple wires allowed) OUTSIDE the solenoid, where essentially no B-field lines actually "cut" the wires in the external wire-loop.
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> Questions -
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> 1. -- If the current in the solenoid is CHANGING, so the flux INSIDE the wire loop is changing, will a current be produced in the external wire loop? The answer is surely YES, even though essentially no B-field lines actually "cut" the wires in the external wire-loop.
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> 2 - How does this happen physically, that is, how does the external wire-loop (red) "FEEL" the change in the magnetic flux down inside the solenoid?

I am surprised to find a physics Professor asking this question as it is my understanding that current scientific teachings explain this quite clearly. I think it all comes down to which of these two formulae is the fundamental one

(a) the flux-cutting rule $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ or (1)

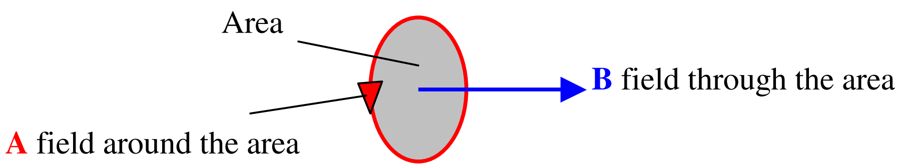
(b) the non-flux-cutting rule $\mathbf{E} = -\dfrac{d\mathbf{A}}{dt}$. (2)

Clearly (2) applies to the induction into the external coil when the flux Φ in the solenoid is changing, the more often used voltage induction

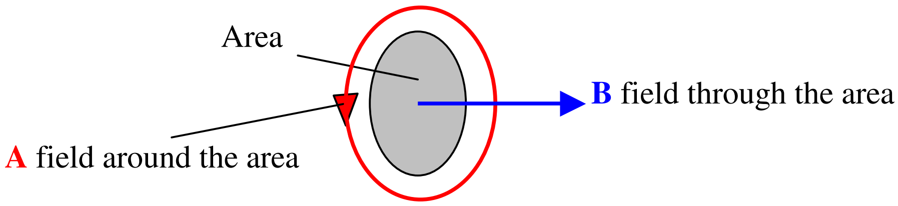
$$V = -\frac{d\Phi}{dt} \qquad (3)$$

being derived from (2) via the relationship between Φ, the closed area integral of the **B** field *within* the solenoid and the closed line integral of the **A** field forming a closed circle around the area

$$\Phi = \oint \mathbf{B}.ds = \oint \mathbf{A}.d\mathbf{l}\,. \qquad (4)$$



Note that (4) applies even if the line integral is taken some distance *outside* area within which the B field flows.



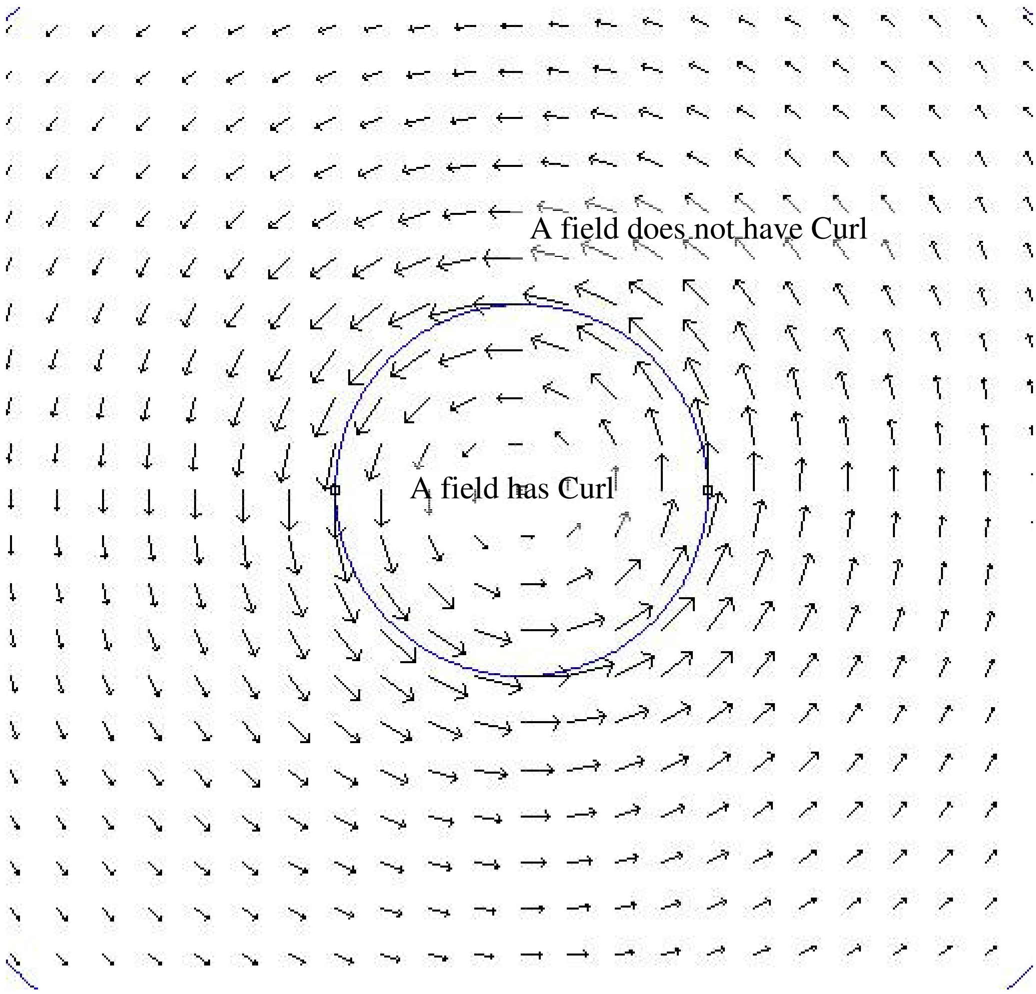
Thus the **A** field there exists within a medium (air) where there is no **B** field at the position of the **A** field. This is the point that many people don't get. If the **B** field is changing with time, then so is the **A** field *outside* the solenoid, where the test coil exists. Then (4) tells you the magnitude of the **A** field and differentiation of (4) with respect to time gives via (2) the volts per turn. That magnetic vector potential field **A** is the answer to the query.

Perhaps some people are surprised that the magnetic vector potential **A** can exist in a region where there is no magnetic field **B**, because the latter after all is related to **A** by

$$\mathbf{B} = \nabla \times \mathbf{A} = \mathrm{Curl}(\mathbf{A})\,. \qquad (5)$$

But the Curl function is just a complex arrangement of the spatial gradients of the field, often stated as a measure of how the field varies spatially at right angle to itself. A uniform **A** field has no spatial gradients and that is one example of an **A** field where there is no **B** field present (but it should be noted that to create such a uniform **A** field locally there must be some **B** field in a far distant region of space associated with some moving charge in that distant region).

Another example where Curl(**A**)=0 appears in this image that shows the **A** field both within and without the solenoid core.



Within the core the **A** field increases amplitude with increasing radius. This **A** field has Curl, hence there is also the **B** field present there. Outside the core the **A** field has reducing amplitude with increasing radius, and this field does not have Curl, thus there is no **B** field there. This field puts paid to the notion that the Curl, as its name implies, is a property of the vector to curl around itself or is a measure of how much the field changes at right angles to itself, as both these properties are there but the

Curl is zero. Clearly any coil wound around the core is within that zero Curl (**B**=0) field, and if the flux in the core is changing with time then so is that external **A** field hence via (2) creates the **E** field that drives the mobile electrons in the conductor to create the induced voltage.

A further question posed was

> 3 - If this system is now working as a transformer, a voltage will be produced in the external wire loop -- and a current in a closed circuit to which the "red wires" in the diagram are attached (not shown). But note that the FLUX due to current in the external wire loop is NOT ALL contained inside the solenoid. In the diagram (and depending on geometries) - perhaps 1/3 of the FLUX inside the external wire loop is contained inside the solenoid, as an example. Thus, the "LENZ effect" will be asymetrical between the wire loop and the solenoid. Will this result in a "reduced Lenz effect" (RLE)?

The coupling coefficient between the two coils is less than one, but to call this a reduced Lenz effect is misleading. The long used equivalent circuit for a transformer allows for loss of flux from the primary coil, but not the necessarily the other way round. A far better theoretical model (found here https://www.overunityresearch.com/index.php?action=dlattach;topic=2609.0;attach=14949) solves the transformer problem in the magnetic domain, and that easily deals with the secondary flux loss. It also reveals far more about the inner workings of the transformer than the electrical model (a model that assumes a "perfect transformer" that magically works without any magnetic field, then supplies external add-ons to account for the need for a magnetic field). That model, although extensively used, hides the real workings of the device. The magnetic domain model shows how the primary reacts to the magnetic flux losses and it is found that this supposed reduced Lenz effect does not lead to any striking effects, and certainly not overunity.

Smudge