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• *The Big Misconception About Electricity (or how do circuits transport energy?)*

tinyurl.com/WS-VeritCircuit
www.phys-l.org/archives/2021/11_2021/threads.html
tinyurl.com/WS-HSPoynting
amasci.com/elect/poynt/poynt.html
en.wikisource.org/wiki/On_the_Transfer_of_Energy_in_the_Electromagnetic_Field

A recent "Veritasium" video incited considerable discussion on the Phys-L list—Derek Muller questions how energy is transported in circuits, invoking the Poynting vector and making (Poynting's historical) case that energy is transported through the space directly between the source and the load as electric and magnetic fields. This is a wonderful example of appropriate models for appropriate learner—for instance, grade school children learn about electrons transporting energy through DC circuits as if electrons "put on an energy hat" at the battery and "drop their energy hat off" at the bulb filament. Later we learn about AC circuits and discover this can't possibly be true—the electrons in the power company generators ultimately energizing my home never leave the generator windings, so those electrons can't possibly transport energy to me. More sophisticated intermediate models like those widely championed by Modeling Physics and Chabay and Sherwood are now found in most university texts; these largely focus on the role surface charges have in creating electric fields inside (and surrounding) circuit wires. Finally, mathematically demanding and more complete field models like that of Poynting focus on both the electric and magnetic fields associated with circuits (these usually arise in classes on waveguides and antennas in the standard curriculum) and the resulting energy transport.

All scientific models are incomplete by nature, but we learn from and can use them all in appropriately limited cases. I think Muller deliberately oversimplifies and dramatizes this point, titillating his viewers with "these were the lies you were taught." The discussion of the undersea telegraph cables and his 300,000 km long transmission waveguide example seem overly contrived and perhaps less germane, but similarly captivating to his intended audience—they tell a (somewhat peripheral) story. Muller's video has solid physics citations (including to Feynman and *AJP*) in the video text description.

The Phys-L conversations invoked excellent (and quite non-canonical) online educational resources by Nick Lucid of "The Science Asylum" introducing the Poynting vector at a HS level, a collection of carefully drawn webpages by William Beatty (with more online and offline citations), as well as a link to Poynting's original paper. These final resources were posted to Phys-L by G. Zani of Brown University. Very interesting things to think and know about for those of us teaching and presenting introductory circuit physics, significantly extending the canonical treatments of the physics of "simple" circuits.

• *Perimeter Institute Outreach Newsletter*

landing.perimeterinstitute.ca/student-and-teacher-workshops-new-breakout-activity-and-online-tips
perimeterinstitute.ca/

The Perimeter Institute for Theoretical Physics continues its excellent outreach programs for teachers, recently announcing online workshops for HS students on "Gravity and Black Holes," and online worldwide teacher professional development workshops on "Optics and Telescopes," "Explorer l'Espace les Exoplanètes" (in French), breakout activities, classroom demonstrations, simulations, webcasts and more. The link is worth adding to your regular browser bookmarks for physics professional development.

• *Big Clive on "How to use your trashy meter without blowing it up (much)"*

tinyurl.com/WS-BigCliveDMM
bigclive.com/
www.harborfreight.com/7-function-digital-multimeter-63759.html

Manxian electronic project impresario Big Clive has made a 24 minute video about the ubiquitous inexpensive Digital Multimeter (DMM; $0-10 at Harbor Freight Tools here in the US). Anyone even possibly interested in learning about electricity should probably get or be given one of these inexpensive devices, which are so unprofitable to sell that nobody has made a good video on how to use them before now. Fuses for other meters can be more expensive than this DMM, which we use for freshman labs. Big Clive explains and demonstrates the commonly used functions of the meter (opening them up for show), how the meter works, manual ranging and accuracy, fuse replacement, discusses safety and frequently comments and compares to more expensive DMMs. He also shows how to test LED function and testing for a kind of diode on the meter, while presenting the infamous "scratchy peeper" controversy.