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arXiv submission submit/1191647

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arXiv:submit/1191647
From: Bob Eisenberg <beisenbe@rush.edu>
Date: Tue, 24 Feb 2015 10:21:09 EST (443kb)

Title: Mass Action and Conservation of Current
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Electronics has remade our world. Electronic models are precise, robust and work well over a wide range of conditions without changing parameters. In these models, current flow is exactly the same everywhere in a series of devices. Interruptions anywhere stop current everywhere, even far away. Electrical potentials change automatically to ensure the same current flows everywhere. Chemical and biochemical models have been built on conservation of matter, expressed as the law of mass action, with constant rate constants. Biochemical technology has made striking progress by making compounds, not so much by making devices. Device design is difficult: rate constants of laws of mass action are found experimentally to change with conditions. The law cannot serve the same role that circuit models do. The LAW OF MASS ACTION DOES NOT AUTOMATICALLY CONSERVE CURRENT, as is clear from a simple example: A ==> B ==> C. The Appendix identifies special symmetrical cases in which charge flow is conserved. The law of mass action, however, does not FORCE a series of chemical reactions to conserve current. Interruption of far-away current does not stop current everywhere in a series of chemical reactions (analyzed by mass action), and so does not obey Kirchoff's current law. The Appendix evaluates consequences when current flow is not conserved. I FEAR CLASSICAL MODELS OF MANY REACTIONS WILL BE IN PERIL WHEN CURRENT FLOW IS EXAMINED. An Energetic Variational Approach EnVarA has recently been developed by Chun Liu, more than anyone else, to ensure that charge flow is conserved globally, along with mass, in dissipative systems like ions in solution or proteins. I believe robust models and device designs in the chemical world will not be possible until the law of mass action and Kirchoff's current law are embedded together in a consistent variational model of energy and dissipation.

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