Introduction:

In the modern theory of electromagnetism, a topological theory can be expressed in terms of an exterior differential system of two postulates:

1. Flux is Conserved:
2. Currents are conserved:

The thermodynamic field “intensities” is defined of inexact 1-form potentials A. The exact 3-form current density J is defined by 2-form density of thermodynamic field quantities G(D,H). The two form is associated with forces and the 2-form density G associated with sources. From these postulates you can roughly deduce two of the classical PDE’s:

1. = 0
2. = J

The “modern” and “classical” electromagnetic theory have the same base of PDE’s. The differences are due to the equations two thermodynamic categories that are topologically distinct. The 1-form of potentials can have non-unique but topologically closed components, . That do not contribute to the 2-form of intensities F, as . Similarly, the 2-form density of excitations can have n0n-unique but closed components , which don’t contribute to 3-form density of currents J as d. The non- uniqueness can appear as discontinuities in solution amplitude or as multi-values as envelope solutions.

A topological perspective of E&M demonstrates that the Maxwell’s electromagnetic theory is universal and goes beyond theory’s that impose geometric constraints. The topological perspective leads to quantum-like structures and topological defects such as charge quantum without the imposition of quantum mechanics.

In conventional electrodynamics when we use a potential 1-form A for F as the fundamental object the usual considerations of wanting the field theory to be invariant under local U(1) gauge changes dictate that A must define a U(1) connection 1-form. However, the group that plays the fundamental role in topological electromagnetism seems to be SL(4), not SO(2). Reduction from SL(M) to SO(3,1)(M) is an essential step from the standpoint of introducing gravitation into the model, or deducing gravitation from it. The use of a constitutive law can give a simple and direct route for effecting the reduction from SL(M) to SO(3,1)(M). However it lacks an immediate topological construction. This either suggests that one cannot find a completely topological formulation for electromagnetism and must eventually resort to geometrical axioms or that we need to look for a more topological basis for the constitutive law.