DENNIS THE, McGill University, Dept. of Math & Stats, 805 Sherbrooke St. West, Montreal, QC H3A 2K6
Symmetries, conservation laws, and cohomology of Maxwell's equations using potentials

We discuss the symmetry and conservation law structure for the free-space Maxwell's equations in Minkowski space and two of its potential systems:

(1) the standard Lagrangian potential system using $F = dA$, and

(2) a natural potential system obtained by introducing joint covariant vector potentials on both F and its (Hodge) dual $*F$.

In the absence of gauge constraints, the local symmetry, adjoint-symmetry and conservation law structure of these systems follows as a consequence of their local 1-form and 2-form cohomology, together with a general theorem describing how local symmetries of a potential system with gauge freedom project to local symmetries of the original system.

With Lorentz gauge imposed, the standard potential system is well known to inherit the Killing symmetries of Maxwell's equations, but not the inversion (conformal) symmetries. In contrast, the joint potential system with Lorentz gauges imposed admits inversion-type symmetries, as we show by a classification of first-order symmetries (of a certain geometric form) for this system. Finally, we derive new nonlocal classes of symmetries and conservation laws of Maxwell's equations as a result of this classification.

This talk is based on joint work with Stephen Anco.