

Actions, symmetries, and gauge theories

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Suppose that we have some theory which is invariant under the action of a gauge group, G . Since this theory is a gauge theory, it can be derived from a singular Lagrangian or Lagrangian density, L . Now suppose that the action for this theory,

$$S = \int L(q, \dot{q})$$

is invariant under the action of some group H . What is the relationship between the groups G and H ?

I guess the reason I'm interested in asking this is to find out whether or not the symmetries of an action functional must necessarily be the same as the symmetries of the resultant equations of motion for the theory. As an extension, I wonder if the symmetries of an action could generate a different symmetry group in the equations of motion. It strikes me that this is an obvious question, but I can't seem to find any (rigorous) information on it.

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