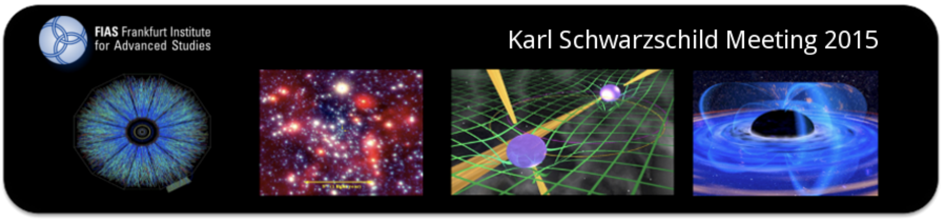

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General Relativity from a Canonical Transformation Formalism

Thursday 23 July 2015 17:00 (30 minutes)

Any physical theory that follows from an *action principle* should be *invariant in its form* under mappings of the reference frame in order to comply with the *general principle of relativity.* The required form-invariance of the action principle implies that the mapping must constitute a particular *extended canonical transformation.*

In the realm of the covariant Hamiltonian formulation of field theory, the term "extended" implies that not only the *fields* but also the *space-time geometry* is subject to transformation.
A *canonical* transformation maintains the general form of the action principle by simultaneously defining the appropriate transformation rules for the fields, the conjugate momentum fields, and the transformation rule for the Hamiltonian.
Provided that the given system of fields exhibits a particular *global* symmetry, the associated extended canonical transformation reveals exactly the particular amended Hamiltonian that is form-invariant under the corresponding *local* symmetry.

This will be worked out for a Hamiltonian system of scalar and vector fields that is presupposed to be form-invariant under space-time transformations $x^\mu \mapsto X^\mu$ with $\partial X^\mu / \partial x^\nu = \mathrm{const.}$, hence under *global* space-time transformations such as the Poincarè transformation. The corresponding amended system that is form-invariant under *local* space-time transformations $\partial X^\mu / \partial x^\nu \neq \mathrm{const.}$ then describes the coupling of the fields to the space-time geometry and thus yields the dynamics of space-time that is associated with the given physical system.

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