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New approaches to constrained dynamics and Hamilton-Jacobi procedures in general relativity

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Élie Cartan's invariant integral formalism is extended to gauge field theory, including general relativity. This constitutes an alternative procedure that is equivalent to the Rosenfeld, Bergmann, Dirac algorithm. In addition, a Hamilton-Jacobi formalism is developed for constructing explicit phase space functions in general relativity that are invariant under the full four-dimensional diffeomorphism group. These identify equivalence classes of classical solutions of Einstein's equations. Each member is dependent on intrinsic spatial coordinates and also undergoes non-trivial evolution in intrinsic time. The intrinsic coordinates are determined by the spacetime geometry in terms of Weyl scalars. The implications of this analysis for an eventual quantum theory of gravity are profound.

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