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Generic General Relativity from action principle and general principle of relativity

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We derive the generic portion of the theory of General Relativity which emerges by presuming merely the action principle and the general principle of relativity to hold. Hence, we isolate those physical theories whose action functional is invariant in its form under arbitrary transformations of the reference frame. Transformations of the dynamical variables which maintain the form of the action functional constitute the group of canonical transformations. In the case of a dynamical spacetime, not only the transformation of the physical fields, but also the mapping of the quantities determining the spacetime geometry must be canonical in order to maintain the form of the action functional.

Following the reasoning of gauge theories, the corresponding locally form-invariant system is worked out by means of a canonical transformation. We thus encounter an amended Hamiltonian with the property to be form-invariant under arbitrary spacetime transformations. The amended system then complies with the general principle of relativity and describes both the dynamics of the given physical system's fields and their coupling to the quantities describing the spacetime geometry. This way, we uniquely determine how spin-0 and spin-1 matter fields couple to spacetime dynamics.

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