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Formulación de Hamilton-Jacobi para teorías gauge no abelianas

The Yang-Mills theory is a non-abelian gauge theory that describes the fundamental forces of the standard model. The gauge nature of free non-Abelian Yang-Mills gauge theories for symmetry groups SU(N) is analyzed in this work using the Hamilton-Jacobi formulation of Carathéodory equivalent Lagrangians. The gauge symmetry of the theory is implied by the presence of constraints, which are restrictions on dynamic variables of the system and are interpreted as partial differential equations (PDEs). These equations must satisfy integrability conditions by being involutive in order to ensure that the system is solvable, which gives rise to a new set of PDEs, which together with the initial ones, constitute the complete set of Hamilton-Jacobi partial differential equations (HJ-PDEs). The set of HJ-PDEs is solved using the Cauchy characteristic equations method, which allows finding the system's equations of motion. The Hamilton-Jacobi equations allow identifying the degrees of freedom of the theory and the associated field equations, which are consistent with other theories. In addition, gauge conditions are implemented, which are additional constraints on gauge fields that uniquely fix their value at each point in spacetime, to eliminate arbitrariness in the equations of motion generated by indeterminate parameters.

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