Symplectic Structure of Constrained Systems: Gribov Ambiguity and Classical Duals for 3D Gravity

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Abstract

The present thesis is divided into two parts. Part I is devoted to the study of Gribov ambiguity in gauge systems and its relation with the appearance of degeneracies in the symplectic structure of the corresponding reduced phase space after gauge fixation. Part II is concerned with classical dual field theories for three-dimensional Einstein gravity and the symplectic structure on coadjoint orbits of the corresponding asymptotic symmetry group.

In Part I, the Gribov problem is studied in the context of finite temperature QCD and the structure of the gluon propagator is analyzed. The standard confined scenario is found for low temperatures, while for high enough temperatures deconfinement takes place and a free gluon propagator is obtained. Subsequently, the relation between Gribov ambiguity and degeneracies in the symplectic structure of gauge systems is analyzed. It is shown that, in finite-dimensional systems, the presence of Gribov ambiguities in regular constrained systems always leads to a degenerate symplectic form upon Dirac reduction. The implications for the Gribov-Zwanziger approach to QCD and the symplectic structure of the theory are discussed.

In Part II, geometrical actions for three-dimensional Einstein gravity are constructed by studying the symplectic structure on coadjoint orbits of the asymptotic symmetry group. The geometrical action coming from the Kirillov-Kostant symplectic form on coadjoint orbits is analyzed thought Dirac's algorithm for constrained systems. By studying the case of centrally extended groups and semi-direct products, the symplectic structure on coadjoint orbits of the Virasoro and the BMS_3 group are analyzed. This allows one to associate separate geometric actions to each coadjoint orbit of the solution space, leading to two-dimensional dual field theories for asymptotically AdS and asymptotically flat three-dimensional gravity respectively.