Friday 2/23: Hongwei ‘Teddy’ Tan - Thesis Defense: Symmetry Charges on Reduced Phase Space and Asymptotic Flatness

Abstract:

Though general relativity (GR) is proven to be a successful theory in describing the macroscopical nature of our universe, it still has several problems to be resolved. One of them is known as the time problem of GR. GR is a pure constraint theory, and the time evolution of the system is a gauge transformation, without carrying any physical information. One potential resolution to this issue is the relational formalism, which considers the dynamics of a material frame by coupling it to gravity. This approach allows for constructing gauge invariant observables and subsequent quantization.

One realization of the relational formalism is the Brown-Kuchaˇr formalism. In this formalism, the gravity couples Brown-Kuchaˇr dust fields, and the Brown-Kuchaˇr dust fields play the roles as a family of observers. Then, one can introduce a gauge fixing scheme to the system and construct gauge invariant observables (Dirac observables) in the reduced phase Space. The probe time of the dust plays the role as the physical time at each point of the spacetime. In this thesis, we consider the Brown-Kuchaˇr formalism in an asymptotically flat background. A set of boundary conditions for the asymptotic flatness are formulated for Dirac observables on the reduced phase space. We compute the boundary term of the physical Hamiltonian, which is identical to the ADM mass. We construct a set of the symmetry charges on the reduced phase space, which encompass both the bulk terms and the boundary terms are conserved by the physical Hamiltonian evolution. The symmetry charges generate transformations preserving the asymptotically flat boundary conditions. Under the reduced-phase-space Poisson bracket, the symmetry charges form an infinite dimensional Lie algebra after adding a central charge. A suitable quotient of this algebra is analogous to the BMS algebra at spatial infinity by Henneaux and Troessaert.