# Stony Brook University
# The Graduate School

## Doctoral Defense Announcement

## Abstract

### Transport Processes in High Temperature QCD Plasmas

By

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The transport properties of the high temperature QCD plasmas can be described by kinetic theory based on the Boltzmann equation. At a leading-log approximation, the Boltzmann equation is reformulated as a Fokker-Planck equation. First, we compute the spectral densities of $T^{\mu\nu}$ and $J^{\mu}$ by perturbing the system with weak gravitational and electromagnetic fields. The spectral densities exhibit a smooth transition from free-streaming quasi-particles to hydrodynamics. This transition is analyzed with hydrodynamics and diffusion equation up to second order. We determine all of the first and second order transport coefficients which characterize the linear response in the hydrodynamic regime. Second, we simulate the wake of a heavy quark moving through the plasmas. At long distances, the energy density and flux distributions show sound waves and a diffusion wake. The kinetic theory calculations based on the Boltzmann equation at weak coupling are compared to the strong coupling results given by the AdS/CFT correspondence.

By using the hard-thermal-loop effective theory, we determine the photon emission rate at next-to-leading order (NLO), i.e. at order $g^2 m_D/T$. There are three mechanisms which contribute to the leading-order photon emission: $2\leftrightarrow2$ elastic scatterings, $1\leftrightarrow2$ collinear bremsstrahlung, and $1\leftrightarrow1$ quark-photon conversions due to soft fermion exchange. At NLO, these three mechanisms are not completely independent. When the transverse momentum becomes soft, the Compton scattering with a soft gluon reduces to wide-angle bremsstrahlung. Similarly, bremsstrahlung reduces to the quark-photon conversion process when the photon carries most of the incoming momentum. Therefore, the rates should be matched to determine the wide-angle NLO correction. Collinear bremsstrahlung can be accounted for by solving an integral equation which corresponds to summing ladder diagrams. With $O(g)$ corrections in the collision kernel and the asymptotic mass of quarks, we determine the NLO correction from collinear processes.

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