Parton Chemistry and Non-Equilibrium HTL Resummation

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A partonic fireball, possibly created in ultrarelativistic heavy ion collisions, will not be in equilibrium at least in its early stage. However, as indicated by transport models [1], thermalization might be achieved quickly. A complete chemical equilibration of the quarks and gluons, on the other hand, may never take place. The chemical evolution of the fireball can be described by means of rate equations taking the most important reactions for the chemical equilibration ($gg \leftrightarrow ggg$, $gg \leftrightarrow q\bar{q}$) into account [2]. Starting from initial conditions for the temperature and the parton density at the time, at which the system can be described by thermal distributions, taken from transport models, the time evolution of the parton densities as been derived. It was shown, that in particular the quark densities are always far below their equilibrium value.

As an application of this result, the photon spectra from a QGP phase at RHIC and LHC have been estimated [3], starting from recent results for the photon production rates [4]. Due to the small quark densities the photon yield is strongly suppressed compared to the equilibrium situation.

A more sophisticated treatment of the photon production out of equilibrium should start from a non-equilibrium calculation of the photon rates. For this purpose the HTL resummation technique has to be generalized to non-equilibrium situations. Using the real time formalism within the Keldysh representation the HTL photon self energy and the HTL resummed photon propagator in non-equilibrium have been constructed [5]. Furthermore it has been shown that there are no pinch singularities [6] to leading order using this method. As an example the electron interaction in a non-equilibrium QED plasma has been derived.

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