Centrality dependence of the emission of thermal photons from fluctuating initial conditions*

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Event-by-event fluctuations in the initial density profile in the hydrodynamical modeling of ultrarelativistic heavy ion collisions have been shown to enhance the production of thermal photons compared to a smooth initial profiles [1]. This enhancement is originating from the fact that hot spots in the fluctuating initial conditions produce much more photons with transverse momenta $p_T > 1$ GeV due to strong temperature dependence of the photon emission rates.

In this work the event-by-event fluctuating initial states are obtained from Monte Carlo Glauber model and density is distributed around the positions of the wounded nucleons using 2-dimensional Gaussians with width σ. These initial states are then evolved with (2+1)-dimensional ideal hydrodynamics [2] and thermal photon emission is obtained by integrating over the whole medium using thermal emission rates [3, 4]. The switch from plasma emission rate to hadron gas emission rate is assumed to happen instantaneously at temperature $T_s = 170$ MeV.

In the figure 1 we have plotted the p_T-spectra of thermal photons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV for different centralities. We can see from the figure that the enhancement is more prominent in the peripheral collisions: the exponential slope of the spectra in the region $2 < p_T < 4$ GeV is 10%, 12% and 16% flatter for fluctuating initial conditions at 0–20%, 20–40% and 40–60% centrality bins respectively [5]. This shows that the relative importance of the hot spots increases towards peripheral collisions, where the number of sources, *i.e.* the number of participants, is smaller.

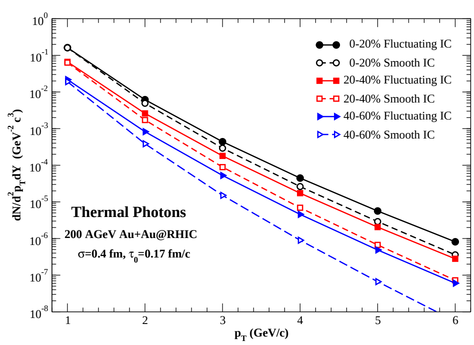

Figure 1: Transverse momentum spectra of thermal photons from smooth and fluctuating initial conditions at RHIC for different collision centralities.

The initial time τ_0 used in these calculations should also vary as a function of centrality – it should be larger for more peripheral collisions. This was studied at LHC energies and we found out that the larger initial times in more peripheral collisions lead to smaller photon yield at large transverse momenta. However, the net effect from density fluctuations and initial time centrality dependence is positive, i.e. the photon production is enhanced relative to the simpler smooth initial state calculation [5].

In figure 2 is plotted the ratio of thermal photons from smooth and fluctuating initial conditions in 0–20% central collisions. Here we have compared the calculations at RHIC and LHC energies and we found out that the enhancement is larger at smaller energies. This suggests that photon measurements at even lower energies than $\sqrt{s_{NN}} = 200$ GeV could be more sensitive to the initial state density fluctuations.

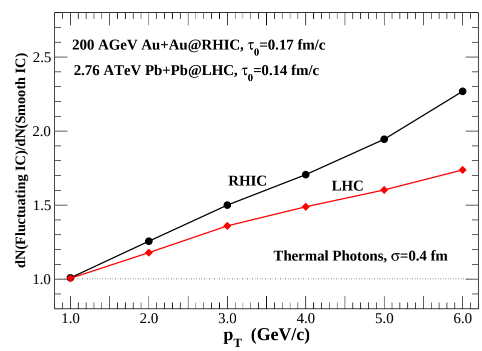

Figure 2: The ratio of thermal photon spectra with fluctuating and smooth initial conditions for 0–20% centrality bin in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV and in Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV.

References

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