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Equation of state and initial temperature of quark gluon plasma at RHIC

In gold-gold collisions of the Relativistic Heavy Ion Collider (RHIC) a perfect fluid of quarks, sometimes called the strongly interacting quark gluon plasma (sQGP) is created for an extremely short time. The time evolution of this fluid can be described by hydrodynamical models. After expansion and cooling, the freeze-out happens and hadrons are created. Their distribution reveals information about the final state of the fluid. To investigate the time evolution one needs to analyze penetrating probes, such as direct photon spectra. Distributions of low momentum photons was published in 2010 by PHENIX. Such low momentum distributions can be compared to hydrodynamics to determine the equation of state and the initial temperature of sQGP. In this paper we analyze a 3+1 dimensional solution of relativistic hydrodynamics. We calculate momentum distribution of low momentum thermal photons and other observables from the model. Using earlier fits of this model to hadronic spectra, we compare photon calculations to measurements from RHIC. We find that the initial temperature of the center of the fireball is at least 519+-12 MeV, while for a time averaged equation of state we get c_s=0.36+-0.02. We also find an interesting shape of direct photon elliptic flow.

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