Low-Energy Thermal Photons from Hadronic Matter

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Within a hadronic model including electromagnetism via a U(1) gauge, we reinvestigate photon Bremsstrahlung from a hot hadron gas as expected to be formed in relativistic heavy-ion collisions at SPS energies [1]. We calculate photon emission from the reactions \( \pi\pi \rightarrow \pi\pi\gamma \) and \( \pi K \rightarrow \pi K\gamma \) by explicit (numerical) evaluation of the multi-dimensional phase space integral (Fig. 1). This, in particular, allows to overcome the commonly employed soft photon approximation (SPA), as well as to incorporate final-state Bose enhancement factors. Both improvements are shown to result in an appreciable increase of the pertinent photon production over previous calculations [2] by up to a factor of 2 at low photon energies \( (q_0=0.1\sim0.5 \text{ GeV}) \).

![Figure 1](image.png)

**Figure 1.** Thermal photon emission rate from Bremsstrahlung via \( \pi\pi \rightarrow \pi\pi\gamma \) (left) and \( \pi K \rightarrow \pi K\gamma \) (right) reactions as a function of photon energy at different temperatures.

We apply the thermal emission rates to the calculation of photon spectra at low transverse momentum \( (q_t) \) in central Pb(158 AGeV)-Pb collisions at SPS via a convolution over a thermal fireball. When comparing the total yield to recent WA98 data [3], we find that Bremsstrahlung leads to a significant improvement in the description of the low-\( q_t \) part of the spectrum (Fig. 2).
Figure 2. Direct low-q, photon spectra as measured in central Pb-Pb collisions at SPS [3] compared to the thermal emission spectra from an expanding fireball with QGP phases.