



Theoretical Study of Photons Spectra around High Energy of Quark-antiquark Using QCD Theory

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Abstract

In this paper, we study and investigate the quark anti-quark interaction mechanism through the annihilation process. The production of photons in association with interaction quark and gluon in the annihilation process. We investigate the effect of critical temperature, strength coupling and photons energy in terms of the quantum chromodynamics model theory framework. We find that the use of large critical temperature $T_c = 134$ allows us to dramatically increase the strength coupling of quarks interaction. Its sensitivity to decreasing in photons rate with respect to strength coupling estimates. We also discuss the effect of photons energy on the rate of the photon, such as energies in range (1.5 to 5 GeV). The photons rate increases association at $T_c = 116 \text{ MeV}$ with the more decreased photons energy compared with photons rate association at $T_c = 116 \text{ MeV}$. This relation of strength coupling α , critical temperature and photons energy are particularly relevant when parametrizing systematic photons emission.

Key Words: Photons Spectra, High Energy, QCD Theory.

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Introduction

The elementary particle is a branch of physics is considered an unbreakable component of small particles and describes the basic building blocks of matter. The quarks idea was introduced in 1964 by both Zweig and Gill Mann independently as fundamental elements of hadrons [1]. The physical particles are considered of the most important field in physics. There are many scientific methods use to investigate and study many phenomena and facts to understanding and construction the nature. Various theories are introduced by scientists in different cite in world to study the interaction of quark-gluon and structure of nucleons [2]. The standard model was confirmed in 2012 when announcement the both CMS and Atlas research groups are detected Higgs boson. It was the final missing part of stander model.

Standard model can be explained the collision process in variety research laboratories It ables to explain the structure of the nucleons up to now [3]. The fundamental particles quarks and gluons are the constituents of the nucleons. The quarks and gluons play an important role to produce the mass of the nucleon and carry 1/2 of its momentum. The spin of nucleons are built up from the spin of quark is fermion has 1/2 and gluonis Boson has spin(1) [4]. The study of dynamics interaction quark and gluon that were understood due to QCD framework depending on heavy hadrons properties in regard understand the hadrons properties using different experiments for hadrons produces at the RHIC, BNL and CERN LHC [5]. Photons are produced in different collisions processes excluded the production of hadronic decays.

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The photons emit throughout the reaction of the heavy-ion medium, and they don't experience subsequent interactions with the system because have color neutral [6]. There are different photons sources such that; prompt photons, thermal photons and photons produced in the preequilibrium by hard interactions. The photons create experimentally in proton-proton collisions and dominate the photons yield at high momentum in heavy ion collisions[7]. The quark-antiquark states are production in collisions, it has been investigated and discussion for evidence of transfer in nuclear matter, where gluons and quarks confine in hadronic matter[8]. In Figure, Feynman diagrams of photon produce mechanisms from, quark-antiquark annihilation.

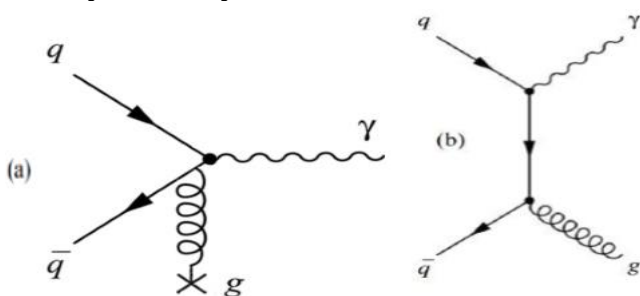


Figure 1. The diagrams of production the photon by quark-anti-quark annihilation [9].

In the last recently, there is a more interesting in strong react in QCD matter under high energy density condition. It is the quark-gluon plasma (QGP). It produces experimentally in collision of heavy ions at the Large Hadron Collider (LHC) in CERN or/and the relativistic collision at RHIC in Brook haven [10]. In addition, the photons emitted throughout of the QGP and emission from the interaction medium are played an important role in that endeavour and unaffected by final state reaction[11]. This work will focus on the study and investigate to produce of photons from interaction of quark and anti-quark in annihilation processes.

Theory

The photons spectrum from quark anti quarks annihilation is given by [12]

$$R_\gamma = \frac{4n_s^2}{(2\pi)^6} F_q(p_\gamma) \iiint F_{\bar{q}}(p_{\bar{q}}) [1 + F_g(p_{\bar{q}}) \sigma_{q\bar{q}}(s) \frac{\sqrt{s(s-4m^2)}}{2E_{\bar{q}}} d^3p_{\bar{q}}] \quad (1)$$

Where n_s is number of quark spins, $F_q(p_\gamma)$ and $F_{\bar{q}}(p_{\bar{q}})$ are Juttner distribution for quark and gluon, $d^3p_{\bar{q}}$ is element valume interaction and $\sigma_{q\bar{q}}(s)$ is total cross section).

The element volume $d^3p_{\bar{q}}$ is written as[13].

$$d^3p_{\bar{q}} \approx \frac{E_{\bar{q}}}{2E_\gamma} ds d\phi dE_{\bar{q}} \quad (2)$$

Where $E_{\bar{q}}$ and E_γ are quark and photons energy, $ds, d\phi$ and $dE_{\bar{q}}$ are element of momentum, solid angle and quarks energies.

The cross section of annihilation process $\sigma_{q\bar{q}}(s)$ is [14].

$$\sigma_{q\bar{q}}(s) = \left(\frac{e_q}{e}\right)^2 \sigma_a(s) \quad (3)$$

Where e_q and e are the quarks and electronic charges and $\sigma_a(s)$ is the effective cross section.

Inserting Eq.(2) and (3) in Eq.(1) to obtained

$$R_\gamma = \frac{4n_s^2}{(2\pi)^6} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 \frac{1}{4E_\gamma} \int F_{\bar{q}}(p_{\bar{q}}) [1 + F_g(p_{\bar{q}}) dE_{\bar{q}} \int \sigma_a(s) \sqrt{s(s-4m^2)} ds \int_0^{2\pi} d\phi] \quad (4)$$

The distribution of quark according Juttner function is given by [15].

$$F_{\bar{q}}(E_{\bar{q}}) = \frac{\lambda_{\bar{q}}}{e^{\frac{E_{\bar{q}}}{T} + 1}} \quad (5)$$

Where $\lambda_{\bar{q}}$ is fugacity of anti-quark. Bose-Einstein distribution $F_B(E)$ for gluon is [16].

$$F_g(E_g) = \frac{\lambda_g}{e^{\frac{E_g}{T} - 1}} \quad (6)$$

Inserting Eqs.(5) and (6) in Eq.(4) and carry out the first integral over $E_{\bar{q}}$ under the condition taken $E_{\bar{q}} \geq \frac{s}{4E_\gamma}$ [17].

$$R_\gamma = \frac{4n_s^2}{(2\pi)^6} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 \frac{1}{4E_\gamma} \left[\int_{\frac{s}{4E_\gamma}}^{\infty} \left[\frac{\lambda_{\bar{q}}}{e^{\frac{E_{\bar{q}}}{T} + 1}} + \frac{\lambda_{\bar{q}}}{e^{\frac{E_{\bar{q}}}{T} + 1}} \frac{\lambda_g}{e^{\frac{E_g}{T} - 1}} \right] dE_{\bar{q}} \int \sigma_a(s) \sqrt{s(s-4m^2)} ds \int_0^{2\pi} d\phi \right] \quad (7)$$

The solution of the first integral for case $E_{\bar{q}} \cong E_g$ is

$$\int_{\frac{s}{4E_\gamma}}^{\infty} \left[\frac{\lambda_{\bar{q}}}{e^{\frac{E_{\bar{q}}}{T} + 1}} + \frac{\lambda_{\bar{q}}}{e^{\frac{E_{\bar{q}}}{T} + 1}} \frac{\lambda_g}{e^{\frac{E_g}{T} - 1}} \right] dE_{\bar{q}} = T \lambda_{\bar{q}} \sum_{n=1}^{\infty} \frac{(-1)^{n+1} \left(\frac{-s}{4E_\gamma T} \right)^n}{n} + T \lambda_{\bar{q}} \lambda_g \sum_{n=1}^{\infty} \frac{e^{-\frac{(2n+1)s}{4E_\gamma T}}}{2n+1} \quad (8)$$

And the third integral is

$$\int_0^{2\pi} d\phi = 2\pi \quad (9)$$

We can Insert Eq.(8) and Eq.(9) in Eq.(7), results

$$R_\gamma = \frac{4n_s^2}{(2\pi)^5} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 \int \left[T \lambda_{\bar{q}} \sum_{n=1}^{\infty} \frac{(-1)^{n+1} \left(\frac{-s}{4E_\gamma T} \right)^n}{n} + T \lambda_{\bar{q}} \lambda_g \sum_{n=1}^{\infty} \frac{e^{-\frac{(2n+1)s}{4E_\gamma T}}}{2n+1} \right] \sigma_a(s) \sqrt{s(s-4m^2)} ds \quad (10)$$

But [13].

$$\sqrt{s(s-4m^2)} \sigma(s) = 4\pi \alpha_0 \alpha_s m^2 \left[\ln \left(\frac{s}{m^2} \right) - 1 \right] \quad (11)$$

Inserting Eq.(11) in Eq.(10) with $s > 4m^2$ to reduced

$$R_\gamma = \frac{4n_s^2}{(2\pi)^5} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 4\pi \alpha_0 \alpha_s m^2 T \lambda_{\bar{q}} \int \left[\sum_{n=1}^{\infty} \frac{(-1)^{n+1} \left(\frac{-s}{4E_\gamma T} \right)^n}{n} + \lambda_g \sum_{n=1}^{\infty} \frac{1}{2n+1} e^{-\frac{(2n+1)s}{4E_\gamma T}} \right] \ln \left(\frac{s}{m^2} \right) - 1 ds \quad (12)$$



we will assume $s = 4m^2z$ to obtained

$$R_\gamma = \frac{4n_s^2}{(2\pi)^5} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 4\pi\alpha_0\alpha_s m^2 T \lambda_q \left[\sum_{n=1}^{\infty} \frac{(-1)^{n+1} (-E_\gamma T)}{n} \int_{4m^2}^{\infty} \frac{-nm^2}{E_\gamma T} e^{-\frac{-nm^2z}{E_\gamma T}} \left[\ln\left(\frac{4m^2z}{m^2}\right) - 1 \right] dz + \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{2n+1} \left(\frac{-E_\gamma T}{(2n+1)m^2}\right) \int_{4m^2}^{\infty} \frac{-(2n+1)m^2}{E_\gamma T} e^{-\frac{(2n+1)m^2z}{E_\gamma T}} \left[\ln\left(\frac{4m^2z}{m^2}\right) - 1 \right] dz \right] \quad (13)$$

For $m^2 \ll E_\gamma T$ we can neglect the $\sum_{i=1}^{\infty} \frac{(-x)^k}{k!}$ for

$$(-x)^k = \left(-\frac{m^2}{E_\gamma T}\right)^k [13], \text{ then integral reduced to}$$

$$\int_1^{\infty} \frac{-E_\gamma T}{nm^2} e^{-\frac{-nm^2z}{E_\gamma T}} [\ln z + \ln 4 - 1] dz = C + \ln\left(\frac{m^2}{4E_\gamma T}\right) + \ln n + 1 \quad (14)$$

And

$$\int_1^{\infty} \frac{-E_\gamma T}{(2n+1)m^2} e^{-\frac{-(2n+1)m^2z}{E_\gamma T}} [\ln z + \ln 4 - 1] dz = [C + \ln\left(\frac{m^2}{4E_\gamma T}\right) + \ln(2n+1) + 1] \quad (15)$$

Substitute both Eq.(14) and Eq.(15) in Eq.(13) to results

$$R_\gamma = \frac{4n_s^2}{(2\pi)^5} \frac{F_q(p_\gamma)}{4E_\gamma} \left(\frac{e_q}{e}\right)^2 \frac{1}{4E_\gamma} 4\pi\alpha_0\alpha_s T m^2 [\lambda_{\bar{q}} \sum_{n=1}^{\infty} \frac{(-1)^{n+1} (E_\gamma T)}{nm^2} \left[\ln\left(\frac{4E_\gamma T}{m^2}\right) - C - \ln n - 1 \right] + \lambda_{\bar{q}} \sum_{n=1}^{\infty} \frac{(-1)^{n+1} E_\gamma T}{2n+1} \frac{E_\gamma T}{(2n+1)m^2} \left[\ln\left(\frac{4E_\gamma T}{m^2}\right) - C - \ln(2n+1) - 1 \right]] \quad (16)$$

But the power series reduced to [18].

$$\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{(2n+1)^2} = \left(1 - \frac{1}{2^2}\right) \zeta(2) \sim \frac{\pi^2}{6} \quad (17)$$

And

$$\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2} = \frac{\pi^2}{6} \quad (18)$$

Subsuming Eq.(17) and Eq.(18) into Eq.(16) at $\lambda_g \sim 1$, we get

$$R_\gamma = \frac{4n_s^2}{(2\pi)^5} F_q(p_\gamma) \left(\frac{e_q}{e}\right)^2 \pi\alpha_0\alpha_s T^2 \lambda_{\bar{q}} \left(\frac{\pi^2}{6}\right) \left[\ln\left(\frac{4E_\gamma T}{m^2}\right) - C - \ln n - \ln(2n+1) - 1 \right] \quad (19)$$

The Juttner distribution function for quark in Eq.(5) for $E_\gamma \gg T$ reduce to

$$\frac{\lambda_q}{e^{\frac{E_\gamma}{T} + 1}} \approx \lambda_q e^{-\frac{E_\gamma}{T}} \quad (20)$$

Then inserting Eq.(20) in Eq.(19) and assume the annihilation coefficient $C_{an} = C + 1 + \ln n + \ln(2n+1)$ with $n_s = 2$ to obtaine.

$$R_\gamma = \frac{\alpha_0\alpha_s}{3(2\pi)^2} \left(\frac{e_q}{e}\right)^2 T^2 \lambda_{\bar{q}} \lambda_q e^{-\frac{E_\gamma}{T}} \left[\ln\left(\frac{4E_\gamma T}{m^2}\right) - C_{an} \right] \quad (21)$$

Where α_0 is the electrodynamic strength constant $\alpha_0 = \frac{e^2}{\hbar c} = (137)^{-1}$, α_s is the chromodynamic strength constant, $\lambda_{\bar{q}}$ and λ_q are the fugacity of quarks and anti quarks with finite quark mass m is written as [19]

$$m = gT = \sqrt{4\pi\alpha_s T} \quad (22)$$

The Eq.(21) with Eq.(22) reduced to

$$E_\gamma \frac{dn_\gamma}{dp_\gamma d^4x} = \frac{\alpha_0\alpha_s}{3(2\pi)^2} \left(\frac{e_q}{e}\right)^2 T^2 \lambda_{\bar{q}} \lambda_q e^{-\frac{E_\gamma}{T}} \left[\ln\left(\frac{4E_\gamma}{4\pi\alpha_s T}\right) - C_{an} \right] \quad (23)$$

The quantum chromo dynamic strength coupling is calculated using [20].

$$\alpha_s = \frac{6\pi}{(33-2n_f) \ln \frac{8T}{T_c}} \quad (24)$$

The transition energy is [21].

$$T_c = \left(\frac{90B}{\pi^2 n_{gq}}\right)^{\frac{1}{4}} \quad (25)$$

Where B is the Bag constant with bag model and n_{gq} is the number of gluons and quarks degrees of freedom. It is given by [22].

$$n_{gq} = n_g + \frac{7}{8} (n_q + n_{\bar{q}}) \quad (26)$$

Results

The photons spectra that are emission from interaction quark anti-quark constituent of QGP calculation is calculated depending on the distribution function for state of the fermions (quark and anti-quark) and gluon (boson) at critical temperatures (110 and 126 MeV). To calculate the rate of the photon, we must estimation the quarks charge and flavour number of system, the quarks charge is obtained through the summation charge 60

$\sum \left(\frac{e_q}{e}\right)^2 = 2/9$ of quarks-antiquarks for $s\bar{s} \rightarrow \gamma g$ system where charge of strange is $\frac{e_q}{e} = -1/3$ and anti-strange is $\frac{e_{\bar{q}}}{e} = 1/3$. While the net favor number is $n_f = 8$ for $s\bar{s} \rightarrow \gamma g$ interaction system. To evaluate the critical temperature from Eq.(25), we estimate the degrees of freedom of the quark-gluon system from Eq.(26) by taking the $n_g = n_s \times n_c = 16$ where $n_s = 2$ and $n_c = 8$ are the gluons spin and color states and $n_q = n_{\bar{q}} = n_c \times n_s \times n_f = 48$ where $n_c = 3, n_s = 2$ and $n_f = 8$ are the number of quark colour, spin and flavour degrees of freedom to results $n_{gq} = 58$. We construct the critical temperature of quarks and gluons system by using Eq.(25) with taking the Bag constant $B^{1/4} = 200$ and 230 MeV [23] to, the results of critical estimation are shown in table(1).

Table 1. Result of critical temperature calculation using the Bag mode of the quarks system for $s\bar{s} \rightarrow \gamma g$ System

Bag constant $B^{1/4} MeV$	Critical temperature $T_c MeV$
200	116
230	134



Additionally, the strength coupling contributions can be calculation using Eq.(24) with take the critical temperature from table (1) and flavor number $n_f = 6$ for $s\bar{s} \rightarrow \gamma g$ system, results shows in table (2).

Table 2. The Running strength coupling at $T_c = 116$ and 134 MeV for quarks interaction for $s\bar{s} \rightarrow \gamma g$ System

$T Mev$	The strength coupling α_s	
	At $T_c = 116$ MeV	At $T_c = 134$ MeV
170	0.36463	0.38732
190	0.34886	0.36959
210	0.33580	0.35496
230	0.32475	0.34263
250	0.31524	0.33206
270	0.30694	0.32287

In addition to strength coupling in table(2), we take the photon energy $E_\gamma = 1.5$ to $5 GeV$, $T=170$ to 270 MeV and fugacity of quark and anti-quark are $\lambda_q=0.06, \lambda_{\bar{q}}=0.06$ respectively with taking Eq.(23) to find the photons spectrum rate where the annihilation coefficient is $C_{an} = 1.415$ [24]. Results are shown in table (3) and table (4) and figures (1) and (2) respectively for critical temperature $T_c = 116$ and 134 MeV.

Table 3. Table (4): Rate of photons emission from quarks interaction $s\bar{s} \rightarrow \gamma g$ at $T_c = 116 MeV$ with $\lambda_q=\lambda_{\bar{q}}=0.06$ with flavor number $n_f = 6$.

$E_\gamma Ge$	$\Gamma_{qg}^{Co}(E, p) \frac{1}{GeV^2 fm^4}$					
	T=170 MeV	T=190 MeV	T=210 MeV	T=230 MeV	T=250 MeV	T=270 MeV
	$\alpha_s = 0.36463$	$\alpha_s = 0.34886$	$\alpha_s = 0.33580$	$\alpha_s = 0.32475$	$\alpha_s = 0.31524$	$\alpha_s = 0.30694$
1.5	4.7928 5E-14	1.2949 3E-13	2.8721 3E-13	5.4840 3E-13	9.3054 4E-13	1.4337 8E-12
2	3.6927 9E-15	1.4110 1E-14	4.1909 1E-14	1.0314 E-13	2.1968 4E-13	4.1759 6E-13
2.5	2.4258 5E-16	1.2828 7E-15	4.9761 E-15	1.5326 8E-14	3.9572 3E-14	8.8982 8E-14
3	1.4862 7E-17	1.0804 7E-16	5.4328 6E-16	2.0773 6E-15	6.4437 4E-15	1.6971 7E-14
3.5	8.7647 3E-19	8.7323 8E-18	5.6736 5E-17	2.6839 9E-16	9.9658 3E-16	3.0625 5E-15
4	5.0473 9E-20	6.8807 1E-19	5.7668 5E-18	3.3691 6E-17	1.4947 E-16	5.3488 8E-16
4.5	2.8605 E-21	5.3303 1E-20	5.7569 7E-19	4.1494 2E-18	2.1971 2E-17	9.1456 5E-17
5	1.6026 9E-22	4.0796 8E-21	5.6743 9E-20	5.0423 5E-19	3.1844 4E-18	1.5407 8E-17

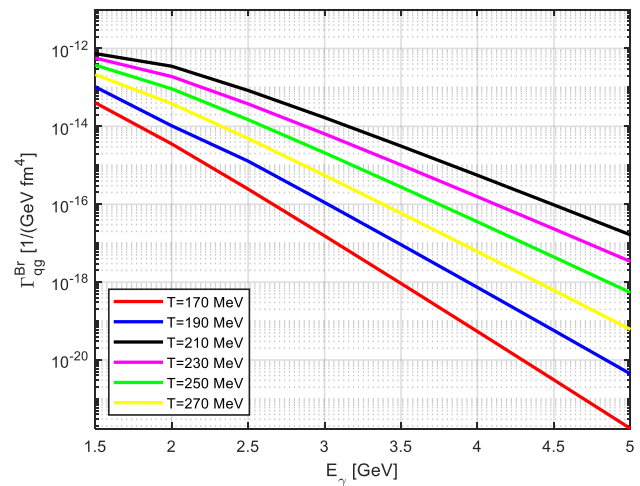


Figure 1. The photon spectrum for $s\bar{s} \rightarrow \gamma g$ system at $T_c = 110$ MeV, $\lambda_q=\lambda_{\bar{q}}=0.06$ and $n_f = 6$. $4.79285E-14$

Table 4. Rate of photons emission from quarks interaction $s\bar{s} \rightarrow \gamma g$ at $T_c = 134$ MeV with $\lambda_q=\lambda_{\bar{q}}=0.06$ with flavor number $n_f = 6$.

$E_\gamma Ge$	$\Gamma_{qg}^{Co}(E, p) \frac{1}{GeV^2 fm^4}$					
	T=170 MeV	T=190 MeV	T=210 MeV	T=230 MeV	T=250 MeV	T=270 MeV
	$\alpha_s = 0.387$	$\alpha_s = 0.369$	$\alpha_s = 0.354$	$\alpha_s = 0.342$	$\alpha_s = 0.332$	$\alpha_s = 0.3228$
1.5	4.6005 8E-14	1.2303 5E-13	2.6974 7E-13	5.0813 7E-13	8.4834 8E-13	1.2812 E-12
2	3.6635 8E-15	1.393E -14	4.1170 1E-14	1.0080 5E-13	2.1356 3E-13	4.03642 E-13
2.5	2.4400 4E-16	1.2858 1E-15	4.9705 9E-15	1.5259 3E-14	3.9268 9E-14	8.80095 E-14
3	1.5065 4E-17	1.0919 3E-16	5.4752 3E-16	2.0880 8E-15	6.4607 4E-15	1.69749 E-14
3.5	8.9288 E-19	8.8717 E-18	5.7499 4E-17	2.7138 7E-16	1.0055 3E-15	3.08376 E-15
4	5.1601 2E-20	7.0164 1E-19	5.8671 1E-18	3.4205 8E-17	1.5146 E-16	5.41033 E-16
4.5	2.9321 8E-21	5.4504 6E-20	5.8739 1E-19	4.2253 9E-18	2.2333 4E-17	9.28104 E-17
5	1.6462 8E-22	4.1806 3E-21	5.8025 6E-20	5.1465 4E-19	3.2447 1E-18	1.5675 E-17

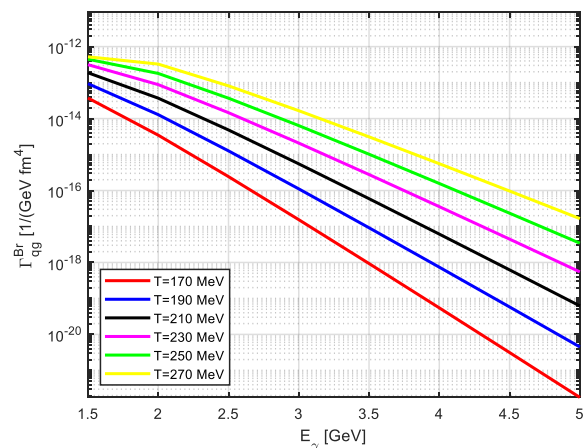


Figure 2. The photon spectrum for $s\bar{s} \rightarrow \gamma g$ system at $T_c = 134$ MeV, $\lambda_q=\lambda_{\bar{q}}=0.06$ and $n_f = 6$



Discussion

Depending on results, we presented calculated results for the calculation of critical temperature, strength coupling and photons rate produced and also the photons spectrum from the interaction of quarks through the annihilation process at finite temperature (170 - 270 MeV) with using fugacity of quark and anti-quark. The evaluation has been done in two different critical temperature and quarks number flavor $n_f = 6$. Photons spectrum is plotted in Figures 1 and 2. In Figures 1 and 2, the rate of photons are produced with different initial temperatures for variety quark flavors in annihilation processes. The photons rate is to be increased due to increase temperature of the system and decreased the strength coupling in both critical temperature of quark flavor $n_f = 6$. In Figure 1, the photons spectrum with the critical temperature 110MeV is less compare with the photons spectrum in Figures 2 with the critical temperature 126MeV. It indicates that the use of flavour number, fugacity, freedom number and photons energy parameters in the photons rate in two figures enhancement the photons rate calculation and creation the stability in the 1.5 GeV of the photons rate evolution. The calculation at such stable photons rate indicate that producing the rate of photon in the energy range 1.5–2.0 GeV. Then the increased of temperature of system $T > 170$ MeV indicate the photons produced increased with instable rate and the photons rate would be more with the increased temperature. However, we can believe it performing the photon produces for unstable interaction with suitable choices of annihilation processes parameters at the photons energies $E_\gamma \geq 2\text{GeV}$. It can be shown a clear cut about the stabilities of photons emission for the different temperature at the photons energy $E_\gamma \geq 2\text{GeV}$ for both figures. Similarly, we can find the photons produced increases with decreases the strength coupling in table (3) and (4). The photons produced are found to be large at large critical temperature $T_c = 134\text{ MeV}$ compared to the photons produced at low critical temperature $T_c = 116\text{ MeV}$ with the same systems $\bar{s} \rightarrow \gamma g$ in interaction system form with the quark number flavor $n_f = 6$ at similar temperature $T = 170$ to 270 MeV. The emission photon rate is increasing in the highly and to effect by the increased temperature. It shows to be large near temperature system $T = 270$ MeV. On the other hand, the suppression in the photon emission is less for both figures with increase photon energy at $T = 0.270$ GeV. Because of that suppression of emission rate increases for

increases the photon energy $E_\gamma \gg T$. From both Figures 1 and 2, we can see the comparing results of photons rate produces at different temperature $T = 0.170$ to 0.270 GeV for annihilation process of the photons produce. We can find that the photons emission rate contribution is effective higher in lowering photon energy $E_\gamma = 1.5\text{ GeV}$ in compared to large photons energy for annihilation processes, and it is less dominated in the higher energy for both critical temperature.

Conclusion

We conclude that the strength coupling and critical temperature are influenced largely on the photon emission yield of the annihilation interaction through the number of freedom and flavor number parameterization factors enhancement the stability of photons emission. Results calculation of emission photon produce and photons rate is a function of photon energy and strength coupling, there are incorporated to give improve data result in emission photon spectrum. Thus, the consideration of critical temperature and temperature parameters have an important role in emission of the photon in the higher energy collisions.

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