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Theoretical Study of Photon Transition for Quark–Quark Interaction at Bremsstrahlung Process

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ABSTRACT

In this thesis the photons rate for quarks interaction at the Bremsstrahlung process have been studied and investigated according to quantum chromodynamic and quantum picture theory. A two quarks wave function state $|\psi(\vec{P}_1, \tau)\rangle$ and $|\psi(\vec{P}_0, \tau)\rangle$ for initial and outgoing state in Hilbert space are assumed to investigate the quarks at bremsstrahlung. Photonic rate are evaluated depending on mathematical treatment of quarks interaction to evaluate the rate emission constant according to estimation strong coupling photons energies, flavor quantum number, color quantum numbers, static electromagnetic coupling constant, color charge, electric charge, critical temperature and thermal energies for quarks system. Various six at $u g \rightarrow d g \gamma$, $\bar{s} g \rightarrow \bar{u} g \gamma$, $c g \rightarrow u g \gamma$, $\bar{b} g \rightarrow \bar{u} g \gamma$, $c g \rightarrow \bar{s} g \gamma$ and $\bar{b} g \rightarrow \bar{s} g \gamma$ quarks systems have adapted to study photons rate emission occur and investigate the spectrum photons at bremsstrahlung system. The rate photons production in quarks interaction at bremsstrahlung process were calculated using many different thermal energies at range $T_{th} = 125, 175, 225, 275, 325, 375, 425$ with two different critical temperature under limit that satisfied quarks at hadronic phase $150 < T_c < 200$ MeV with taken photons energies at range limited $E_\gamma = 0.5 \rightarrow 5$ GeV. Photonic rate spectrum and all coefficients are evaluated using many computer programs (Matlab program) version 2015.

Keywords

Theoretical interaction, photon transition, quark-quark interaction Bremsstrahlung Process.

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Introduction

Elementary particle physics is a domain of physics that uses the scientific method to describe the fact to construction of the universe, including addition of a substance, scope and other, and the interactions occurring between the components of the universe, and limiting the definition of the physical interactions of particles is the lack of definition of the fact that this area as defined by (Adrian buzatu *et al.*, 2011). For understand the nucleons (protons, neutrons) structure more and deeper, and study the phase quark-gluon from the universe phases

after the big bang stage, we use many theories in this theses, chromodynamic (Abachi *et al.*, 1994; Abad *et al.*, 1979; Abarbanel *et al.*, 1975; Ali *et al.*, 1988, 1990) and quantum picture theory, Which is considered one of the theories from quantum field theory (David *et al.*, 2008; Donald *et al.*, 2000; Das *et al.*, 2005), to calculation the coupling constant between the particles, photons rate emission and the relation between them for Bremsstrahlung Process which represented on case from three cases (annihilation particles, coumpoten effect, and

Bremsstrahlung Process) happened in the Wiliam, 1994).
 quark-gluon plasma (Martin, 2006, 2008;

Theoretical background

By using the logarithmic principles produce for coupling constant (Yogesh Kumar *et al.*, 2013):

$$\alpha_s(\mu) = \frac{6\pi}{(33-2N_f)\ln\frac{\mu}{\Lambda_{QCD}}} \dots\dots\dots(1)$$

For thermal energy $\Lambda_{QCD} = T_C$ and $\mu \approx 8T$ for high energy collision. eq.(1) becomes:

$$\alpha_s(T) = \frac{6\pi}{(33-2N_f)\ln\left(\frac{8T}{T_C}\right)} \dots\dots\dots(2)$$

Where T_C is the transition temperature, which characterizes the critical point in which quarks and gluons become confined

The photons rate emission is given by (Yogesh Kumar *et al.*, 2013; Steffenand *et al.*, 2001):

$$E \frac{dN}{d^4x d^3q} = \zeta(\alpha_s, J_{TL}, E, T) = \frac{1}{2\pi^2} \alpha \alpha_s \sum_f e^2 \frac{T^4}{E^2} e^{\frac{-E}{T}} (J_T - J_L) Y(E, T) \dots\dots\dots(3)$$

Since this factor $Y(E, T)$ represents the incipient integration:
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$$Y(E, T) = \int_0^\infty dp (p^2 + (p + E)^2) [n_f(p) - n_f(p + E)] \dots\dots(4)$$

Whereas

$$n(p) = \frac{1}{e^{\frac{p}{T}} + 1}, n(p + E) = \frac{1}{e^{\frac{p+E}{T}} + 1} \dots\dots\dots(5)$$

$$p^2 + (p + E)^2 = 2p^2 + 2EP + E^2 \dots\dots\dots(6)$$

After integration becomes a compensation former worker, several parts (Hadi *et al.*, 2016):

The first part is: $\int_0^\infty \frac{2p^2}{e^{\frac{p}{T}} + 1}$ becomes:

$$\int_0^\infty \frac{2p^2 e^{-\frac{p}{T}}}{e^{-\frac{p}{T}} + 1} = 2 \int_0^\infty p^2 e^{-\frac{p}{T}} dp \left[\frac{1}{e^{-\frac{p}{T}} + 1} \right] \dots\dots\dots(7)$$

And using the following rounding:

$$\frac{1}{e^{-\frac{p}{T}} + 1} = \left[e^{\frac{p}{T}} - e^{\frac{2p}{T}} + e^{\frac{3p}{T}} - e^{\frac{4p}{T}} + e^{\frac{5p}{T}} - e^{\frac{6p}{T}} \dots \dots \dots \right]$$

(Vladimir, 2003)...(8)

Rounding compensation in the integration produces:

$$2 \left[\int_0^\infty p^2 \cdot dp - \int_0^\infty p^2 e^{\frac{p}{T}} \cdot dp + \int_0^\infty p^2 e^{\frac{2p}{T}} \cdot dp - \int_0^\infty p^2 e^{\frac{3p}{T}} \cdot dp + \dots - \int_0^\infty p^2 e^{\frac{np}{T}} \cdot dp \right] \dots\dots\dots(9)$$

Using relationship:

$$\Gamma(n) = (n-1)! = \int x^{n-1} e^{-x} dx \dots\dots\dots (10)$$

Produces:

$$\int_0^\infty p^2 e^{\frac{p}{T}} \cdot dp = -T^3 \Gamma(3) \dots\dots\dots(\text{Vladimir, 2003})(11)$$

$$\int_0^\infty p^2 e^{\frac{2p}{T}} \cdot dp = -\frac{T^3}{2^3} \Gamma(3) = -\frac{T^3}{8} \Gamma(3) \dots\dots\dots(12)$$

$$\int_0^\infty p^2 e^{\frac{3p}{T}} \cdot dp = -\frac{T^3}{3^3} \Gamma(3) = -\frac{T^3}{27} \Gamma(3) \dots\dots\dots(13)$$

$$\int_0^\infty p^2 e^{\frac{4p}{T}} \cdot dp = -\frac{T^3}{4^3} \Gamma(3) = -\frac{T^3}{64} \Gamma(3) \dots\dots\dots(14)$$

$$\int_0^\infty p^2 e^{\frac{5p}{T}} \cdot dp = -\frac{T^3}{5^3} \Gamma(3) = -\frac{T^3}{125} \Gamma(3) \dots\dots\dots(15)$$

The general solution for first part is:

$$\int_0^\infty \frac{2p^2}{e^{\frac{p}{T}+1}} = 2 \left(\int_0^\infty p^2 dp + \frac{T^3}{1^3} \Gamma(3) - \frac{T^3}{2^3} \Gamma(3) + \frac{T^3}{3^3} \Gamma(3) - \frac{T^3}{4^3} \Gamma(3) + \frac{T^3}{5^3} \Gamma(3) + \dots - \frac{T^3}{n^3} \Gamma(3) \right) \dots\dots\dots(16)$$

The second part of the integration : $\int_0^\infty \frac{2E p}{e^{\frac{p}{T}+1}}$, it solves the same technical after multiplication and division in the facilities produce :

$$\int_0^\infty \frac{2E p}{e^{\frac{p}{T}+1}} = 2 E \left(\int_0^\infty p^2 dp - \frac{T^2}{1^2} \Gamma(2) + \frac{T^2}{2^2} \Gamma(2) - \frac{T^2}{3^2} \Gamma(2) + \frac{T^2}{4^2} \Gamma(2) \dots\dots\dots + \frac{T^2}{n^2} \Gamma(2) \right) \dots\dots\dots(17)$$

By the same way we obtained to the solution of the third parts:

$$\int_0^\infty \frac{E^2 dp}{e^{\frac{p}{T}+1}} = E^2 \int_0^\infty e^{-\frac{p}{T}} dp \left[e^{\frac{p}{T}} - e^{\frac{2p}{T}} + e^{\frac{3p}{T}} - e^{\frac{4p}{T}} + e^{\frac{5p}{T}} - \dots - e^{\frac{np}{T}} \right] \dots\dots\dots(18)$$

$$\int_0^\infty \frac{E^2 dp}{e^{\frac{p}{T}+1}} = \left(\right)$$

$$\Gamma(1) - \frac{T}{2} \Gamma(1) + \frac{T}{3} \Gamma(1) - \frac{T}{4} \Gamma(1) + \dots - \frac{T}{n} \Gamma(1) \dots\dots\dots(19)$$

All this represented the parts of integral, when the equation (6) is multiplying in factor, $n(p) = \frac{1}{e^{\frac{p}{T}} + 1}$.

Another parts which represented the same equation multiplying in the factor, $n(p + E) = \frac{1}{e^{\frac{p+E}{T}} + 1}$ contain many parts too.

The solution first part ($\int_0^\infty \frac{2p^2 dp}{e^{\frac{p+E}{T}} + 1}$)

Multiplying by the factor ($e^{-\frac{(p+E)}{T}}$) and take the integral with same technique in previous integrals, we obtain:

$$\int_0^\infty \frac{2p^2 e^{-\frac{(p+E)}{T}} dp}{e^{-\frac{(p+E)}{T}} + 1} dpz = \int_0^\infty 2 p^2 e^{-\frac{(p+E)}{T}} . dp [e^{\frac{p+E}{T}} - e^{\frac{2(p+E)}{T}} + e^{\frac{3(p+E)}{T}} - e^{\frac{4(p+E)}{T}} \dots e^{\frac{n(p+E)}{T}}] \dots\dots\dots(20)$$

$$\int_0^\infty \frac{2p^2 e^{-\frac{(p+E)}{T}} dp}{e^{-\frac{(p+E)}{T}} + 1} dp = 2 \left(\int p^2 . dp - e^{\frac{E}{T}} \left(\frac{-T^3}{1^3} \Gamma(3) + e^{\frac{2E}{T}} \left(\frac{-T^3}{2^3} \Gamma(3) - e^{\frac{3E}{T}} \left(\frac{-T^3}{3^3} \Gamma(3) + e^{\frac{4E}{T}} \left(\frac{-T^3}{4^3} \Gamma(3) - e^{\frac{5E}{T}} \left(\frac{-T^3}{5^3} \Gamma(3) + \dots e^{\frac{nE}{T}} \left(\frac{-T^3}{n^3} \Gamma(3) \right) \right) \right) \right) \right) \right) \dots\dots\dots(21)$$

The second part:

$$\int_0^\infty \frac{2EP dp}{e^{\frac{p+E}{T}} + 1} = 2E [\int p . e^{-\frac{(p+E)}{T}} dp (e^{\frac{(p+E)}{T}} - e^{\frac{2(p+E)}{T}} + e^{\frac{3(p+E)}{T}} - e^{\frac{4(p+E)}{T}} + e^{\frac{5(p+E)}{T}} - \dots e^{\frac{n(p+E)}{T}})] \dots\dots\dots(22)$$

$$\int_0^\infty \frac{2EP dp}{e^{\frac{p+E}{T}} + 1} = 2E$$

$$\int_0^\infty p dp - \frac{T^2}{1^2} \Gamma(2) \cdot e^{\frac{E}{T}} + \frac{T^2}{2^2} \Gamma(2) \cdot e^{\frac{2E}{T}} - \frac{T^2}{3^2} \Gamma(2) \cdot e^{\frac{3E}{T}} + \frac{T^2}{4^2} \Gamma(2) \cdot e^{\frac{4E}{T}} - \frac{T^2}{5^2} \Gamma(2) \cdot e^{\frac{5E}{T}} + \dots - \frac{T^2}{n^2} \Gamma(2) \cdot e^{\frac{nE}{T}}$$

)(23)

The third part:

$$\int_0^\infty \frac{2 E^2 dp}{e^{\frac{p+E}{T}} + 1} = \int_0^\infty \frac{2 E^2 e^{-\frac{-(p+E)}{T}} dp}{e^{-\frac{-(p+E)}{T}} + 1} = \int_0^\infty E^2 e^{-\frac{-(p+E)}{T}} dp \left[e^{\frac{p+E}{T}} - e^{\frac{2(p+E)}{T}} + e^{\frac{3(p+E)}{T}} - e^{\frac{4(p+E)}{T}} + e^{\frac{5(p+E)}{T}} \dots \dots + e^{\frac{n(p+E)}{T}} \right]$$

.....(24)

$$\int_0^\infty \frac{2 E^2 dp}{e^{\frac{p+E}{T}} + 1} = \int dp + \frac{T}{1} \Gamma(1) e^{\frac{E}{T}} - \frac{T}{2} \Gamma(1) e^{\frac{2E}{T}} + \frac{T}{3} \Gamma(1) e^{\frac{3E}{T}} - \frac{T}{4} \Gamma(1) e^{\frac{4E}{T}} + \frac{T}{5} \Gamma(1) e^{\frac{5E}{T}} \dots \dots + \frac{T}{n} \Gamma(1) e^{\frac{nE}{T}}$$

)(25)

The general solution of all parts for the integral in equation (3) after canceled the similar factors is:

$$Y(E, T) = 2 T^3 \Gamma(3) \left(\frac{1}{1^3} - \frac{1}{2^3} + \frac{1}{3^3} - \frac{1}{4^3} + \frac{1}{5^3} - \frac{1}{n^3} \right) - 2 E T^2 \Gamma(2) \left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \frac{1}{5^2} \dots \dots - \frac{1}{n^2} \right) + E^2 T \Gamma(1) \left(\frac{1}{1} - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \frac{1}{5} \dots \dots - \frac{1}{n} \right) - 2 T^3 \Gamma(3) \left(\frac{E}{1^3} - \frac{2E}{2^3} + \frac{3E}{3^3} - \frac{4E}{4^3} + \frac{5E}{5^3} - \frac{nE}{n^3} \right) + 2 E T^2 \Gamma(2) \left(\frac{E}{1^2} - \frac{2E}{2^2} + \frac{3E}{3^2} \dots \dots - \frac{nE}{n^2} \right) + E^2 T \Gamma(1) \left(\frac{E}{1} - \frac{2E}{2} + \frac{3E}{3} - \frac{4E}{4} + \dots - \frac{nE}{n} \right)$$

.....(26)

Where:

$$Y(E, T) = 3 \zeta(3) + \pi^2 E / 6 T + (E/T)^2 \ln(2) + 4 Li_3(-e^{-E/T}) + 2 (E/T) Li_2(-e^{-E/T}) - (E/T)^2 \ln(1 + e^{-E/T}) \dots \dots (27)$$

And Li are the Polylogarithmic functions given by (18):

$$Li_a = \sum_{n=1}^{\infty} \frac{z^n}{n^a}, \quad \zeta(3) = 1.202 \dots\dots\dots(28)$$

These factors are calculated according to the chosen system, flavored coefficient depends in his account the preparation of the individual flavor of each quark in the system and according to the following chart:

The total number of flavor is the sum of the individual flavor preparation, according to the relationship:

$$N_f = \sum_{i=1}^6 N_{fi} \dots\dots\dots(29)$$

To calculate the total charge of the system we use relationship:

$$\sum_f e_f^2 = \sum_f e_{q1}^2 + \sum_f e_{q2}^2 \dots\dots\dots(30)$$

Substituting Eq.(27) in Eq.(6) with $E \equiv E_*$

$$\zeta(\alpha_s, J_{TL}, E_*, T) = \frac{1}{2\pi^2} \alpha_s \sum_f e^2 \frac{T^4}{E_*^2} e^{-\frac{E_*}{T}} (J_T - J_L) Y(E_*, T) = 3 \zeta(3) + \pi^2 E_* / 6 T + (E_* / T)^2 \ln(2) + 4 Li_3(-e^{-E_*/T}) + 2 (E_* / T) Li_2(-e^{-E_*/T}) - (E_* / T)^2 \ln(1 + e^{-E_*/T}) \dots\dots\dots(31)$$

$\zeta(\alpha_s, J_{TL}, E_*, T)$ which represented the photons rate for quarks interaction at the Bremsstrahlung process.

Results and Discussion

At the initial thermal energies interaction of quarks began at the bremsstrahlung process of going through several quarks system, it depends on the quantum color hypothesis at QCD theory that followed the emission the photons carry us a many information about the nucleons structures and discussion the nuclear forces.

The important quarks interaction in hadronic phases that through his studies will understand the realities in quark gluon system that explain the origins of the strong forces as well as the fine structure of elementary particles (proton, neutron) (Aurenche *et al.*, 1998). The quarks interaction that occurs within the many quarks mater phases includes three

important interaction (Compton scattering, annihilation and bremsstrahlung), these interactions occur at one time, But make a mental analysis in the study of these interactions, So that each separated by a phenomenon, when examined from the rest of the phenomena, Because of different a Mont of energy each interaction phenomenon for the rest of the phenomena, So one can understand the behavior of particles, According to the form of graphic curves in the search, we will prevail in this thesis to study the phenomenon of (bremsstrahlung) (Aurenche *et al.*, 1997; Landau *et al.*, 1953) in reaction (Quark – gluon).

Tables (5,6,7,8), we note that photonic rate will remain change when change both T_{th} and strong coupling constant α_s , when will the

increased value of T_{th} , the coupling constant α_s is decreasing and the rate of photons production is $\zeta(\alpha_s, J_{TL}, E, T)$ increased, therefore, it was the rate production of photons function at temperature T_{th} and coupling constant α_s , when the temperature T_{th} decreasing the coupling constant α_s increased, Accordingly, at least the rate of photons production.

But when the value of change for T_c , number of flavor (n) and value of energy E_γ , with the increase in energy, and no change another variables, the rate of photons production $\zeta(\alpha_s, J_{TL}, E, T)$ is decreasing, this is what we observe in the figures, supported and approaching from the available experimental data, when the number of flavor is changing

and no change other factor (T_c, T_{th}, E_γ), but absolutely the energy E_s well change, the number of flavor is change, then conclude when the number of flavor is increasing the coupling constant is increasing too, this means deeper, the impact of increased the number of flavor larger from the impact of increased the coupling constant to increasing value of rate photons production, which is supposed to make rate photons production is decreasing not the opposite.

With T_c increasing and no change another variables except the coupling constant α_s , which is increasing when the T_c is increasing, the rate of photons production $\Gamma_\gamma(\alpha_s, T)$ is increasing too.

Table.1 Data results of estimation the flavors quantum number for quarks systems

System	Quarks Mass	$\sum N_f$
u g → d g γ	$m_u = 2.3^{+0.7}_{-0.5} \text{ MeV}/c^2$	3
	$m_d = 4.8^{+0.5}_{-0.3} \text{ MeV}/c^2$	
$\bar{s} g \rightarrow \bar{u} g \gamma$	$m_s = 80 - 130 \text{ MeV}/c^2$	4
	$m_u = 2.3^{+0.7}_{-0.5} \text{ MeV}/c^2$	
c g → u g γ	$m_c = 1.15-1.35 \text{ GeV}/c^2$	5
	$m_u = 2.3^{+0.7}_{-0.5} \text{ MeV}/c^2$	
$\bar{b} g \rightarrow \bar{u} g \gamma$	$m_b = 4.1 - 4.4 \text{ GeV}/c^2$	6
	$m_u = 2.3^{+0.7}_{-0.5} \text{ MeV}/c^2$	
cg → $\bar{s} g \gamma$	$m_c = 1.15-1.35 \text{ GeV}/c^2$	7
	$m_s = 80 - 130 \text{ MeV}/c^2$	
$\bar{b} g \rightarrow \bar{s} g \gamma$	$m_b = 4.1 - 4.4 \text{ GeV}/c^2$	8
	$m_s = 80 - 130 \text{ MeV}/c^2$	

Table.2 Result of the strong coupling for quarks system at critical temperature Tc=150 MeV

system	$\sum N_F$	$\alpha_s(P_{eff})$						
		$P_{eff}=1.0G$ eV at $T_{th} = 125$	$P_{eff}=1.4$ GeV at $T_{th} = 175$	$P_{eff}=1.8G$ eV at $T_{th} = 225$	$P_{eff}=2.2$ GeV at $T_{th} = 275$	$P_{eff}=2.8$ GeV at $T_{th} = 325$	$P_{eff}=3.0$ GeV at $T_{th} = 375$	$P_{eff}=3.4Ge$ V at $T_{th} = 425$
$ug \rightarrow dgy$	3	0.36814	0.31269	0.28106	0.26006	0.24483	0.23314	0.22379
$\bar{s}g \rightarrow \bar{u}gy$	4	0.3976	0.3377	0.30355	0.28087	0.26442	0.25179	0.24169
$cg \rightarrow ugy$	5	0.43217	0.36707	0.32994	0.30529	0.28741	0.27368	0.26271
$\bar{b}g \rightarrow \bar{u}gy$	6	0.47333	0.40202	0.36137	0.33436	0.31478	0.29975	0.28772
$cg \rightarrow sgy$	7	0.52315	0.44434	0.3994	0.36956	0.34792	0.3313	0.31801
$\bar{b}g \rightarrow \bar{s}gy$	8	0.5847	0.49662	0.44639	0.41304	0.38885	0.37027	0.35542

Table.3 Result of the strong coupling for quarks system at critical temperature Tc=200 MeV

$\alpha_s(P_{eff})$	$\sum N_F$	$\alpha_s(P_{eff})$						
		$P_{eff}=3.4G$ eV at $T_{th} = 125$	$P_{eff}=3.4$ GeV at $T_{th} = 175$	$P_{eff}=3.4$ GeV at $T_{th} = 225$	$P_{eff}=3.4$ GeV at $T_{th} = 275$	$P_{eff}=3.4G$ eV at $T_{th} = 325$	$P_{eff}=3.4$ GeV at $T_{th} = 375$	$P_{eff}=3.4$ GeV at $T_{th} = 425$
$ug \rightarrow dgy$	3	0.43395	0.35891	0.31786	0.29126	0.27229	0.25790	0.24651
$\bar{s}g \rightarrow \bar{u}gy$	4	0.46866	0.38763	0.34329	0.31456	0.29407	0.27853	0.26623
$cg \rightarrow ugy$	5	0.50942	0.42133	0.37314	0.34191	0.31965	0.30276	0.28938
$\bar{b}g \rightarrow \bar{u}gy$	6	0.55793	0.46146	0.40868	0.37448	0.35009	0.33159	0.31694
$cg \rightarrow sgy$	7	0.61666	0.51003	0.4517	0.4139	0.38694	0.36649	0.3503
$\bar{b}g \rightarrow \bar{s}gy$	8	0.68921	0.57004	0.50484	0.46259	0.43246	0.40961	0.39151

Table.4 Result of the strong coupling for quarks system at critical temperature Tc=200 MeV

Q(GeV)	α_s					
	$\alpha(n_f=3)$	$\alpha(n_f=4)$	$\alpha(n_f=5)$	$\alpha(n_f=6)$	$\alpha(n_f=7)$	$\alpha(n_f=8)$
1	0.43377	0.46848	0.50921	0.55771	0.61642	0.68893
4	0.23304	0.25169	0.27357	0.29963	0.33117	0.37013
7	0.19636	0.21207	0.23051	0.25246	0.27904	0.31187
10	0.17846	0.19273	0.20949	0.22945	0.2536	0.28343
20	0.1516	0.16373	0.17796	0.19491	0.21543	0.24077
30	0.13933	0.15048	0.16356	0.17914	0.1980	0.22129
40	0.13176	0.14231	0.15468	0.16941	0.18724	0.20927
50	0.12644	0.13655	0.14843	0.16257	0.17968	0.20082
60	0.1224	0.13219	0.14368	0.15737	0.17393	0.1944
70	0.11918	0.12871	0.1399	0.15323	0.16936	0.18928
80	0.11652	0.12584	0.13679	0.14981	0.16558	0.18506
90	0.11427	0.12342	0.13415	0.14692	0.16239	0.18149
100	0.11234	0.12132	0.13187	0.14443	0.15964	0.17842

Table.5 photonic rates in $u g \rightarrow d g \gamma$ system at Bremishthalung process due to TC=150 MeV

E_* (GeV)	$\zeta(\alpha_s, J_{TL}, E_*, T)[GeV^{-2} fm^{-4}], n=3$						
	$T_{th}=125$ MeV	175 MeV	225 MeV	275 MeV	325 MeV	375 MeV	425 MeV
	$\alpha_{esc} = 0.36814$	$\alpha_{esc} = 0.31269$	$\alpha_{esc} = 0.28106$	$\alpha_{esc} = 0.26006$	$\alpha_{esc} = 0.24483$	$\alpha_{esc} = 0.023314$	$\alpha_{esc} = 0.22379$
0.5	9.0484e-8	5.7125e-7	1.9832e-6	5.1462e-6	1.1229e-5	2.1781e-5	3.8748e-5
1	1.3750e-9	2.4205e-8	1.3971e-7	4.7806e-7	1.2256e-6	2.6319e-6	5.0238e-6
1.5	2.4112e-11	1.2850e-9	1.3472e-8	6.6352e-8	2.1583e-7	5.4497e-7	1.1652e-6
2	4.3458e-13	7.1556e-11	1.3902e-9	1.0057e-8	4.2397e-8	1.2870e-7	3.1506e-7
2.5	7.8990e-15	4.0484e-12	1.4699e-10	1.5750e-9	8.6755e-9	3.1918e-8	9.0210e-8
3	1.4407e-16	2.3056e-13	1.5708e-11	2.5036e-10	1.8099e-9	8.1048e-9	2.6556e-8
3.5	2.6318e-18	1.3173e-14	1.6874e-12	4.0105e-11	3.8147e-10	2.0847e-9	7.9389e-9
4	4.8121e-20	7.5395e-16	1.8179e-13	6.4521e-12	8.0877e-11	5.4030e-10	2.3955e-9
4.5	8.8032e-22	4.3197e-17	1.9619e-14	1.0407e-12	1.7209e-11	1.4070e-10	7.2711e-10
5	1.6110e-23	2.4765e-18	2.1197e-15	1.6814e-13	3.6704e-12	3.6751e-11	2.2157e-10

Table.6 photonic rates in system at Bremishthalung process due to TC=150 MeV

E_*	$T_C = 150, n=8 \quad \zeta(\alpha_s, J_{TL}, E_*, T)[GeV^{-2} fm^{-4}]$						
	$T_{th} = 125$	175	225	275	325	375	425
	$\alpha = 0.5847$	0.49662	0.44639	0.41304	0.38885	0.37027	0.35542
0.5	1.4371e-7	9.0728e-7	3.1498e-6	8.1733e-6	1.7834e-5	3.4594e-5	6.1541e-5
1	2.1839e-9	3.8443e-8	2.2189e-7	7.5927e-7	1.9466e-6	4.1801e-6	7.9789e-6
1.5	3.8295e-11	2.0409e-9	2.1396e-8	1.0538e-7	3.4279e-7	8.6554e-7	1.8506e-6
2	6.9021e-13	1.1365e-10	2.2080e-9	1.5973e-8	6.7337e-8	2.0441e-7	5.0039e-7
2.5	1.2546e-14	6.4298e-12	2.3346e-10	2.5014e-9	1.3779e-8	5.0694e-8	1.4327e-7
3	2.2881e-16	3.6618e-13	2.4947e-11	3.9764e-10	2.8745e-9	1.2872e-8	4.2176e-8
3.5	4.1799e-18	2.0922e-14	2.6799e-12	6.3696e-11	6.0586e-10	3.3110e-9	1.2609e-8
4	7.6428e-20	1.1974e-15	2.8872e-13	1.0247e-11	1.2845e-10	8.5812e-10	3.8046e-9
4.5	1.3982e-21	6.8607e-17	3.1160e-14	1.6529e-12	2.7333e-11	2.2346e-10	1.1548e-9
5	2.5586e-23	3.9333e-18	3.3665e-15	2.6705e-13	5.8295e-12	5.8369e-11	3.5190e-10

Table.7 photonic rates in u g → d g γ system at Bremsstrahlung process due to TC=200 MeV

$T_c = 200$, n=3		$\zeta(\alpha_s, J_{TL}, E_*, T)[GeV^{-2} fm^{-4}]$						
	$T_{th} = 125$	175	225	275	325	375	425	
E_*	$\alpha=0.43395$	0.35891	0.31786	0.29126	0.27229	0.25790	0.24651	
0.5	1.0666e-7	6.5570e-7	2.2429e-6	5.7636e-6	1.2488e-5	2.4095e-5	4.2683e-5	
1	1.62086e-9	2.7784e-8	1.5800e-7	5.3541e-7	1.3631e-6	2.9115e-6	5.5339e-6	
1.5	2.8422e-11	1.4750e-9	1.5235e-8	7.4312e-8	2.4004e-7	6.0286e-7	1.2835e-6	
2	5.1226e-13	8.235e-11	1.5722e-9	1.1264e-8	4.7153e-8	1.4237e-7	3.4705e-7	
2.5	9.3110e-15	4.6469e-12	1.6624e-10	1.7639e-9	9.6486e-9	3.5309e-8	9.9370e-8	
3	1.6982e-16	2.6465e-13	1.7764e-11	2.8040e-10	2.0129e-9	8.9658e-9	2.9252e-8	
3.5	3.1022e-18	1.5120e-14	1.9083e-12	4.4917e-11	4.2425e-10	2.3061e-9	8.7450e-9	
4	5.6723e-20	8.6541e-16	2.0559e-13	7.2262e-12	8.9949e-11	5.9770e-10	2.6388e-9	
4.5	1.0377e-21	4.9583e-17	2.2188e-14	1.1656e-12	1.9140e-11	1.5564e-10	8.0094e-10	
5	1.8989e-23	2.8427e-18	2.3972e-15	1.8832e-13	4.0821e-12	4.0665e-11	2.4406e-10	

Table.8 photonic rates in system at Bremishthalung process due to TC=200 MeV

$T_c = 200$, n=8		$\zeta(\alpha_s, J_{TL}, E_*, T)[GeV^{-2} fm^{-4}]$						
	$T_{th} = 125$	175	225	275	325	375	425	
E_*	$0.68921\alpha=$	0.57004	0.50484	0.46259	0.43246	0.40961	0.39151	
0.5	1.6940e-7	1.0414e-6	3.5622e-6	9.1539e-6	1.9834e-5	3.8269e-5	6.7790e-5	
1	2.5742e-9	4.4127e-8	2.5094e-7	8.5036e-7	2.1649e-6	4.6242e-6	8.7891e-6	
1.5	4.5140e-11	2.3426e-9	2.4197e-8	1.1803e-7	3.8123e-7	9.5748e-7	2.0385e-6	
2	8.1359e-13	1.3045e-10	2.4971e-9	1.7889e-8	7.4890e-8	2.2612e-7	5.5120e-7	
2.5	1.4788e-14	7.3803e-12	2.6403e-10	2.8015e-9	1.5324e-8	5.6079e-8	1.5782e-7	
3	2.6971e-16	4.2032e-13	2.8214e-11	4.4534e-10	3.1969e-9	1.4240e-8	4.6459e-8	
3.5	4.9271e-18	2.4015e-14	3.0308e-12	7.1338e-11	6.7381e-10	3.6627e-9	1.3889e-8	
4	9.0089e-20	1.3745e-15	3.2653e-13	1.1477e-11	1.4286e-10	9.4928e-10	4.1910e-9	
4.5	1.6481e-21	7.8750e-17	3.5239e-14	1.8512e-12	3.0398e-11	2.4720e-10	1.2721e-9	
5	3.0159e-23	4.5148e-18	3.8073e-15	2.9909e-13	6.4833e-12	6.4570e-11	3.8763e-10	

Fig.1 The behaviour of strong coupling α a function of Q energy with experimental data

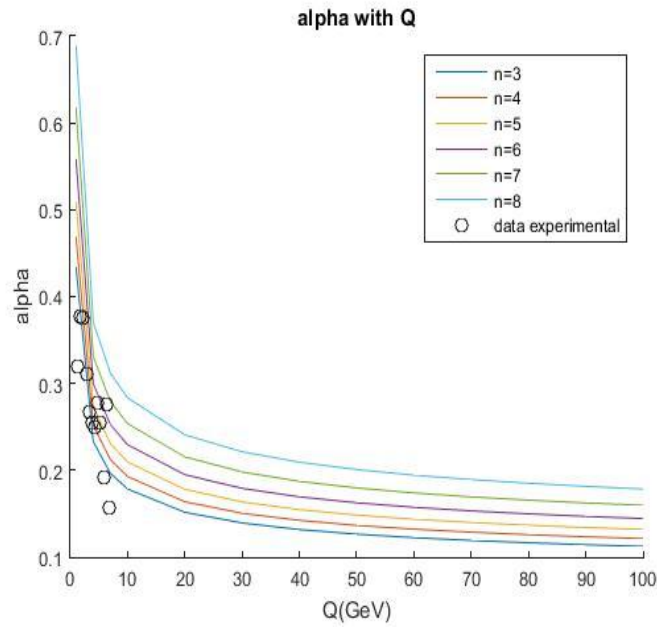


Fig.2 photonic data rates as function for $u\bar{g} \rightarrow d\bar{g}\gamma$ system at $TC=150$ MeV for 125, 175, 225, 275, 325, 375, 425)

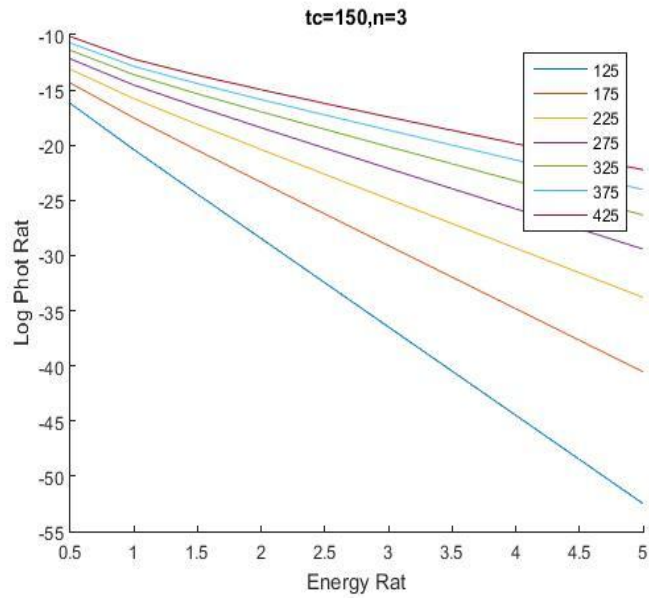


Fig.3 photonic data rates as functions for system at TC=150 MeV for 125, 175, 225, 275, 325, 375, 425)

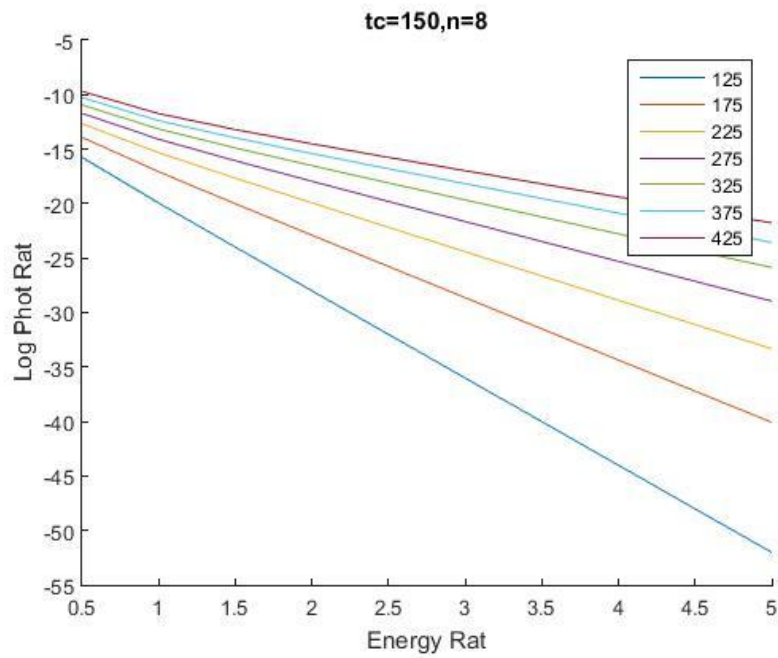


Fig.4 photonic data rates as functions for $u\bar{g} \rightarrow d\bar{g}\gamma$ system at TC=200 MeV for 125, 175, 225, 275, 325, 375, 425)

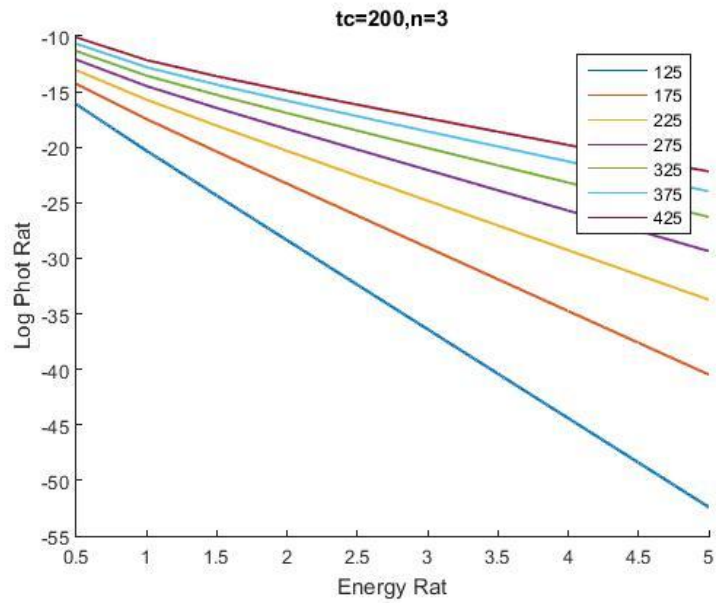
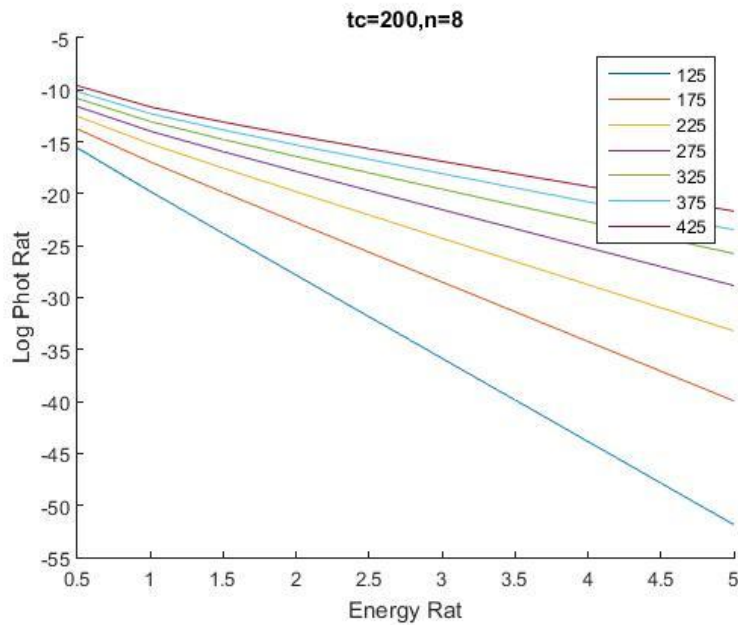


Fig.5 photonic data rates as functions for system at TC=200 MeV for 125, 175, 225, 275, 325, 375, 425)



The result, the effect of T_c , T_{th} and the number of flavor (n) to rate photon production stronger than the effect of fluctuations and changes of coupling constant α_s .

In conclusion, the theoretical produce of photon yield $\zeta(\alpha_s, J_{TL}, E, T)$ in plasma quark-gluon in this theses, calculation theoretically by many theories, quantum field theory one of them, specially chromodynamics theory and Helbert picture. Theoretical form is derived by used the quantum field theory and the other theory branched from previously mentioned.

The results calculation by use many parameters, important one is the coupling constant, and other parameters like the thermal temperature, system temperature photon energy, according to the results showed by the tables and figures in the four chapter obtained to many important conclusions in this search:

1-The photonic rate will remain change when change both T_{th} and strong coupling constant α_s , when will the increment value of T_{th} , the

coupling constant α_s is detraction and the of photons production is $\zeta(\alpha_s, J_{TL}, E, T)$ increment, therefore, it was the production of photons function at temperature T_{th} and coupling constant α_s , when the temperature T_{th} detraction the coupling constant α_s increment, Accordingly, at least the of photons production.

2- when the value of change for T_c , number of flavor (n) and value of energy E_* , with the increment in energy, and no change another variables, the of photons production $\zeta(\alpha_s, J_{TL}, E, T)$ is detraction.

3- when the number of flavor is changing and no change other factor (T_c , T_{th} , E_*), but absolutely the energy E_* well change, the number of flavor is change, then conclude when the number of flavor is increment the coupling constant is increment too, this means deeper, the impact of increment the number of flavor larger from the impact of increased the coupling constant to increment value of photons production, which is supposed to

make photons production is detracted not the opposite.

4-When T_c increment and no change another variables except the coupling constant α_s , which is increment, the T_c is increment, the rate of photons production $\zeta(\alpha_s, J_{TL}, E, T)$ is increment too.

5- The important conclusion must we are focusing on well, the effect of T_c , T_{th} and the number of flavor (n) to rate photon production more powerful than the effect of fluctuations and changes of coupling constant α_s .

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