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IS THE POSSIBILITY OF PRODUCING LOOPED STRING BALLS AT LHC?

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ABSTRACT. A standout amongst the most energizing subjects in Physics is the possibility of producing string balls (looped) at Large Hadron Collider (LHC).The string ball is the principal objective to research this subject. First, we obtain the cross-section production of looped string ball. Then, the number of radiated particles from the left and right regions of string ball is calculated. The string ball cross-section production is multiplied by the number of radiated particles in left and right areas of string for obtaining the particle cross-section at LHC. It's concluded that looped string balls emit more particles with respect to un-looped strings. Next, the cross sections production for Higgs boson radiation from looped string ball and rot to QCD matter is derived. When string balls create at LHC, Massive particles such as Higgs boson evaporate to them. Truth be told string balls at LHC go about as a manufacturing plant for Higgs creation. At that point, Higgs bosons rot to QCD matter. Then the radiation of the looped string ball into top quark is considered. We found that as the string ball mass increases, the effect of formation of the loop on top quark cross-section turns out to be efficiently more viable, because at higher masses there exist more destinations that transmit top quarks. Then again at lower mass, the string ball won't be looped and not ready to emanate heavy particles like top quarks. This prompts a decrease in top creation cross segment using string ball rot to QCD matter and thus to an abatement in cross-section hadronically.

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1. Introduction

The phase change of black holes (BH) of lowest mass into the exceedingly energized long and barbed strings known as “string balls” in string theory.BH are straggly originated by them, since in TeV theory of gravity, string balls are lighter and also easily approachable to LHC or VLHC. If we cpmpare on string scale, the phenomena of scattering (string-string) is replaced by the point-particle type of description of scattering. The string states will turn out to be entangled, exceedingly excited and jagged as the increment in the energy above the string scale. String states like this are usually alluded to as string balls [1]. In the long run at sufficiently high energies, a point is reached called transition point. At that point string ball transforms to a BH [2,3].

On the off chance with dimensions additionally, the string scale may be and at CERN LHC, string balls are produced. Therefore additional string balls can be produced at CERN LHC in comparison to BH as the lighter nature of string ball than black hole [4,5].

These looped string balls might be seen through their gravitational wave, particle emission and different other signatures [6]. In this research, we calculate the production cross segment for looped string ball at LHC. The formation of the loop causes to an adjustment in string ball radiation. We will demonstrate that looped string balls emanate more particles with respect to unlooped strings.
The paper is desiged as: In segment II we get the generation cross segment for transmitted particles from circled string balls at LHC. In area III we give the Higgs boson creation and rot at LHC. Last section is committed to conclusion.

2. The production for radiated particles from looped string balls

The production (cross-section) will be calculated for radiated molecules from looped string ball at LHC in this section. Using the mechanisms in refs [7,8], we consider two independent Hamiltonians related to string ball states and string ball radiations. The τ-translation generating Hamiltonian is defined as:

$$H_1 = \frac{1}{2} l_s^2 (p^i)^2 + \Sigma_{i=1}^{d-2} \Sigma_{m=1}^{\infty} \alpha^i_{-m,right} \alpha^i_{m,right} + \Sigma_{i=1}^{d-2} \Sigma_{m=1}^{\infty} \beta^i_{-m,left} \beta^i_{m,left} - \frac{d-2}{24}$$

and the β translation generating Hamiltonian is given by:

$$H_2 = \Sigma_{i=1}^{N} H_{2,i} = \Sigma_{i=1}^{N} n_{loop} \Big(\frac{kT_{looped}}{N} \Big) + E_p (n_{right,i} + n_{left,i}).$$

In this Hamiltonian n_{loop} indicates whether string is looped (= 1) or not (= 0). The variables $n_{right,i}$ and $n_{left,i}$ indicate whether (= 1) or not (= 0) a particle is radiated of site i at the left and right region of string respectively. N is the number of sites that radiate standard model particles, KT_{looped} is the energy that is supplied to lead to formation of loop and E_p is the emitted particle energy that causes to change in free energy upon radiating of a particle from a string site. The string ball Hagedorn temperature is defined as [3-5]:

$$T_s = \frac{M_s}{\sqrt{8}\pi}; \ and\ \beta = \frac{1}{kT_s}.$$

We write the partition function to count the quantum states of such a string as a function of a complex parameter as τ: $Z_1(\tau) = Tr(e^{2\pi i H_1 \tau})$. Using this function we can obtain the following result for entropy [7]:

$$S_{string} = 2\pi(\sqrt{N_{left}} + \sqrt{N_{right}}) - \frac{3}{4}\ln a\sqrt{N_{left}N_{right}}.$$

This equation shows the relation between string entropy and N radiating sites of string. When the entropy of string ball increases, the number of radiating sites increases and consequently more particles emitted from the string. The mass is proportional to entropy (of a long string) [3-5]. Thus we can easily obtain the amount of N:

$$S_{string} = \frac{M_{SB}}{M_s} \longrightarrow N \equiv \Big(\frac{S_{string}}{4\pi}\Big)^2 = \Big(\frac{M_{SB}}{4\pi M_s}\Big)^2 for N_{left} = N_{right} = \frac{N}{2}.$$

To calculate the probability of a string ball being looped, we express the second partition function as: $Z_2 = \sum_{n_{loop}=0}^{1}\prod_{i=1}^{N} Z_i$

$$Z_i = \sum_{n_{right,i}=0}^{1}\sum_{n_{left,i}=0}^{1}(-1)^{l(n_{left,i}+n_{right,j})}e^{-\beta H_2,j}$$
$$= e^{-\frac{T_{looped}n_{loop}}{NT_s}} + e^{-\left(\frac{T_{looped}n_{loop}}{NT_s}+2\frac{E_p}{kT_s}\right)} + 2(-1)^l e^{-\left(\frac{T_{looped}n_{loop}}{NT_s}+\frac{E_p}{kT_s}\right)}$$

where $l = 0$ and $l = 1$ corresponds to bosonic and fermionic particles respectively. This equation leads to

$$Z_2 \approx \left(2(-1)^l e^{-\left(\frac{T_{looped}}{NT_s}+\frac{E_\rho}{kT_s}\right)} + e^{-\left(\frac{T_{looped}}{NT_s}+2\frac{E_\rho}{kT_s}\right)} + e^{-\left(\frac{T_{looped}}{NT_s}\right)}\right)^N + \left(e^{-\frac{E_\rho}{kT_s}}(1+(-1)^l)e^{\frac{E_\rho}{kT_s}})^2\right)^N.$$

The probability of a string ball being looped is given by the average value of n_{loop}. After some mathematical manipulations, we obtain

$$\langle n_{loop}\rangle = \frac{-1}{N\beta}\frac{\partial}{\partial kT_{looped}}lnZ_2 = \frac{1}{1+Y^N}$$

$$Y = \frac{e^{\left(\frac{T_{looped}}{NT_s}\right)}\left(1+(-1)^l)e^{\frac{E_\rho}{kT_s}}\right)^2}{1+2(-1)^l e^{\left(\frac{T_{looped}}{NT_s}+\frac{E_\rho}{kT_s}\right)}+e^{\left(\frac{T_{looped}}{NT_s}+2\frac{E_\rho}{kT_s}\right)}}.$$

This expression for n_{loop} indicates that, potential is there for the sharp transition between two states: the string is looped if $Y < 1$ and isn't looped if $Y > 1$. To obtain looped string ball production cross section, multiply the string ball cross section production by the probability that the string ball is looped.

$$\sigma_{loopedSB} = \langle n_{loop}\rangle\, \sigma_{SB}$$

$$\sigma^{pp\to SB} = \sum_{ab}\int_z^1 dx_a \int_{\frac{z}{x_a}}^1 dx_b f_{\frac{a}{A}}(x_a,\mu^2)\times f_{\frac{b}{B}}(x_b,\mu^2)\sigma_{SB}(s)\delta\left(x_a x_b - \frac{M_{SB}^2}{s}\right).$$

Here x_a and x_b represent the parton momentum fraction (longitudinal) inside the proton, d denotes extra dimension's number, the centre of mass energy is denoted by $\sqrt{s}' M_{SB}, M_p$ are the string ball mass and plank mass and $\tau = \frac{M_{SB}^2}{s}$ The sum over all partonic contributions is represented by $\sum_{ab}$. In parton-parton collision, the string ball cross section production is defined as [3-5]:

$$\sigma_{SB} \approx \begin{cases} \frac{g_s^2 M_{SB}^2}{M_s^4}, & M_s \ll M_{SB} \ll \frac{M_s}{g_s^2}, \\ \\ \frac{1}{M_S^2}, & \frac{M_s}{g_s} \ll M_{SB} \ll \frac{M_s}{g_s^2}. \end{cases}$$

The production cross sections for looped string ball increases with string ball mass and consequently increases with mass-energy (centre). If looped string balls are produced at LHC, many standard model particles create and rot to matter QCD close to them and this will bring about a contrast between the watched cross sections (hadronic) and the anticipated cross sections. We can obtain the average number of radiated standard model particles from the left region or right region of string ball as following:

$$\left\langle n_{left/righr,i}\right\rangle = \frac{-1}{2N\beta}\frac{\partial}{\partial E_{\rho}}lnZ_2 = \frac{1+(-1)^l e^{\left(\frac{E_\rho}{kT_s}+\frac{T_{looped}}{NT_s}\right)}}{1+2(-1)^l e^{\left(\frac{T_{looped}}{T_s}+\frac{E_\rho}{kT_s}\right)}+e^{\left(\frac{T_{looped}}{T_s}+2\frac{E_\rho}{kT_s}\right)}}\left\langle n_{loop}\right\rangle + \frac{1}{1+(-1)^l e^{\frac{E_\rho}{kT_s}}}\left\langle 1-n_{loop}\right\rangle$$

$$\left\langle n_{left/right}\right\rangle = \frac{N}{2}\left\langle n_{left,i/right,j}\right\rangle .$$

For total observed particle cross section (at LHC) calculations, we have to multiply the quantity (count) of particles created from a solitary string ball with the aggregate string ball generation cross section in pp impacts at LHC.

$$\sigma_{standard\ model\ particle} = \left(\left\langle n_{left}\right\rangle + \left\langle n_{right}\right\rangle\right)\sigma_{SB}.$$

Comparing this cross-section with cross sections in refs [3-5], it concludes that looped string balls radiate more particles respect to unlooped string ball. This cross-section depends upon the Hagedorn temperature of looped string ball.

3. The Higgs boson radiation from looped string ball and decay to QCD matter at LHC

We shall calculate the production cross section for fundamental particles model such as Higgs boson at LHC in this segment. For generating particle masses, Higgs is responsible. An SM Higgs (light) boson less than 200 GeV approximately has been predicted at the Tevatron at Fermilab and by precision (Electroweak) data collected at the CERN (LEP) Large Electron-Positron Collider, at (SLC) Stanford Linear Collider. Other side, Higgs bosons less than 114 GeV has excluded which leaves the comparatively narrow window for the mass by the direct search at LEP2. In this mass range a Higgs boson, frequently likewise alluded to as middle of mass Higgs boson, transcendently rots into base quarks depending whether the last rot is kinematically permitted. A further rot channel which is of phenomenological intrigue is the one into gluons. The aggregate rate for decaying Higgs boson to gluons at principal sequence can be determined as [9]:

$$\Gamma\left(Higgs \to gluons\right) = \left(\frac{\alpha_s}{\pi}\right)\frac{\pi}{288\sqrt{2}}\left[\frac{3}{2\tau}\left(1+(1-\frac{1}{\tau})arcsin^2(\sqrt{\tau})\right)\right]^2$$

where α_s represents the strong coupling constant, $\tau = \frac{M_H^2}{4M_t}^2$ is the renormalization scale, M_t represents the top quark mass and M_H represents the Higgs boson mass. Assuming Higgs bosons elimination and create (top–anti top quarks) with mass Mt, with a subsequent decay to gluons. Denoting this gluon production cross section with $\sigma_{PP\to SB\to Higgs\to glouns}$ and calculate it as following:

$$\sigma_{PP\to SB\to Higgs\to glouns} = \sigma_{PP\to SB\to Higgs}\Gamma\left(Higgs \to gg\right)$$

$$\begin{aligned}\sigma_{PP\to SB\to Higgs} &= \left(\frac{M_{SB}}{4\pi M_s}\right)^2\left(\frac{1+e^{\left(\frac{E_{Higgs}}{kT_s}+\frac{T_{looped}}{T_s}\right)}}{1+2e^{\left(\frac{T_{looped}}{T_s}+\frac{E_{Higgs}}{kT_s}\right)}+e^{\left(\frac{T_{looped}}{T_s}+\frac{2E_{Higgs}}{kT_s}\right)}}\right)\langle n_{loop}\rangle \\ &\quad +\frac{1}{1+e^{\frac{E_{Higgs}}{kT_s}}}\langle 1-n_{loop}\rangle\,\sigma_{SB} \\ \langle n_{loop}\rangle &= \frac{1}{1+\left(\frac{e^{\left(\frac{T_{looped}}{T_s}\right)}+\left(1+E^{\frac{E_{Higgs}}{kT_s}}\right)^2}{1+2e^{\left(\frac{T_{looped}}{T_s}+\frac{E_{Higgs}}{kT_s}\right)}+e^{\left(\frac{T_{looped}}{T_s}+2\frac{E_{Higgs}}{kT_s}\right)}}\right)^{\frac{M_{SB}}{4\pi M_s}}}.\end{aligned}$$

This equation shows that gluon production cross section increases by increasing Hagedorn temperature. Subsequently, without black hole creation at LHC, an improvement in gluon generation cross section can be a critical of TeV (scale string Physics at LHC).

The Higgs boson rate decay to quarks (bottom - anti bottom) may be computed as:

$$\Gamma\left(Higgs \to b\bar{b}\right) = \frac{M_b^2\alpha_s}{6\nu^2 M_H^2}\left[-4C_F\ln\left(1-\frac{M_H^2}{Q}\right)+2C_F\ln\frac{M_b^2}{M_H^2}+2C_F\right],$$

where $\nu = 246GeV$, $C_F = \frac{4}{3}$, $C_A = N$. We signify this bottom quark creation cross section by means of process $PP \to Stringball \to Higgs \to b\bar{b}$ by $\sigma_{PP\to SB\to Higgs\to bottomquarks}$ as below estimatioms:

$$\sigma_{PP\to SB\to Higgs\to bottomquarks} = \sigma_{PP\to SB\to Higgs}\Gamma\left(Higgs \to b\bar{b}\right).$$

When string balls create (at LHC), Massive particles such as Higgs boson evaporate to them. Indeed string balls at LHC go about as a processing plant for Higgs creation. At that point, Higgs bosons rot to QCD matter.

4. Conclusions

We calculate the number of radiated particles from string ball in left and right regions of string ball. We multiply the number of emitted particles in left and right parts by the string ball cross-section to obtain the particle cross-section at LHC. It's concluded that looped string balls radiate more particles respect to unlooped string ball. Next, we discuss the Higgs boson generation and rot at LHC. After that we find the production cross section for radiated top quarks from looped string balls at LHC.

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