

RENORMALIZATION AND TEMPERATURE DEPENDENCE OF DIM 6 GLUON OPERATORS

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Understanding the temperature dependence of the gluon condensate in the pure gauge theory offers a useful picture on the nature of the QCD phase transition. In a recent work, we identified the independent dim 6 twist 4 gluon operators ($O_1 = D_\beta G_{\mu\nu}^a D_\alpha G_{\mu\nu}^a$, $O_2 = D_\mu G_{\alpha\mu}^a D_\nu G_{\beta\nu}^a$, $O_3 = D_\beta G_{\alpha\mu}^a D_\nu G_{\mu\nu}^a$) and calculated their renormalization upto one loop order in the pure gauge theory. We found the scale invariant operators are given as follows:

$$\phi_1 = \alpha_s^{-9/11} \langle O_1 \rangle, \quad \phi_{2,3} = \alpha_s^{-(15 \mp \sqrt{17})/44} \left\langle \frac{-653 \pm 21 \sqrt{17}}{424} O_1 + \frac{1 \mp \sqrt{17}}{8} O_2 + O_3 \right\rangle. \quad (1)$$

Together with the dim 6 scalar operators whose renormalization has been worked out before, our result completes the calculation of renormalization of all the dim 6 gluon operators, hence is a first step toward identifying their mixing and thus a systematic analysis in the operator product expansion (OPE) of heavy quark correlation functions up to dimension 6. After using the equation of motion in the pure gauge theory, only O_1 remains nonzero. As an application, we rewrite the dim 6 scalar and twist 4 operators as $f^{abc} B^a \cdot (B^b \times B^c)$ and $f^{abc} B^a \cdot (E^b \times E^c)$ and estimate their temperature dependence using inputs of dim 4 electric and magnetic condensate extracted from lattice gauge theory. We then improve the previous QCD sum rules for J/Ψ mass near the T_c based on dim 4 operators, by including the contribution of the dim 6 operators to the OPE. We find an enhanced stability in the sum rule and confirm that the J/ψ will undergo an abrupt change in the property across T_c .