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# Shear and Bulk Viscosities of a Gluon Plasma in Perturbative QCD

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We calculate the leading order shear and bulk viscosities,  $\eta$  and  $\zeta$ , of a gluon plasma in perturbative QCD using different treatments for the matrix element of the  $gg \leftrightarrow ggg$  (23) process. A comprehensive comparison of different treatments or models has been made. We find that the Gunion-Bertsch (GB) formula can provide a robust approximation to the exact matrix element for the 23 process. Our result for  $\eta$  using the exact matrix element for the 23 process agrees with that of Arnold, Moore and Yaffe (AMY) at very weak couplings and is smaller than AMY's by about 10-20% at intermediate couplings, which is partly due to finite angle scatterings. We agree with the Arnold, Dogan and Moore's (ADM) leading order result for  $\zeta$  within errors. A better understanding is provided for the equivalence between soft gluon bremsstrahlung in the center of mass frame in the 23 process and collinear splitting in the local rest frame in the leading order, which explains the agreement between the GB formula and AMY's treatment at weak couplings. We also generalize our result to a general  $SU(N_c)$  pure gauge theory and summarize the current status of the viscosity computations in QCD.

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