Correlation Functions and Confinement in Scalar QCD

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The failure of perturbative approach for explorations of confinement necessitates the use of non-perturbative methods. One of the ways to understand the Physics of confinement is to calculate correlation functions in the theory. Such an exploration also confirms which one of the, already proposed, scenarios is the choice of nature. They can also serve as input for calculating other correlation functions, for instance using DSE's.
Since lattice computation with fermions is expensive, only gauge bosons and scalar Higgs of the theory are considered, thus Scalar QCD.

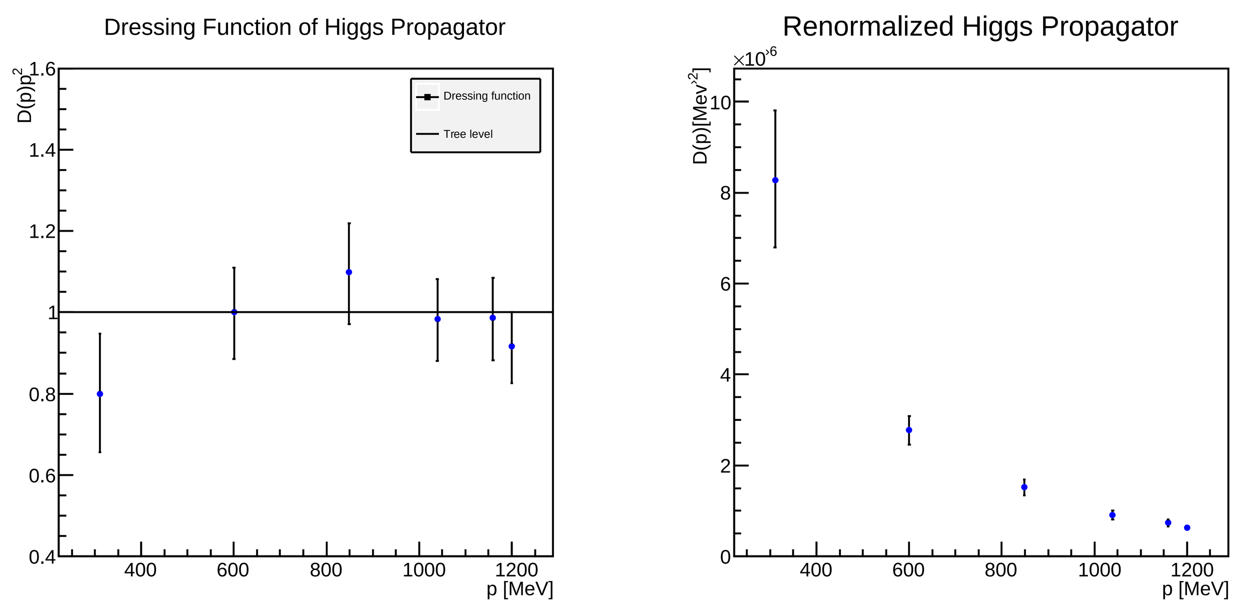
The Lagrangian (continuum version) for the corresponding physics is

$$L = \frac{1}{4}F^a_{\mu\nu}F^{\mu\nu}_a + (D^{ij}_\mu\phi_j)^\dagger(D^\mu_{ik}\phi^k) + \frac{1}{2}m^2\phi^{i\dagger}\phi^i + \lambda(\phi^{a\dagger}\phi^a)(\phi^{b\dagger}\phi^b)$$

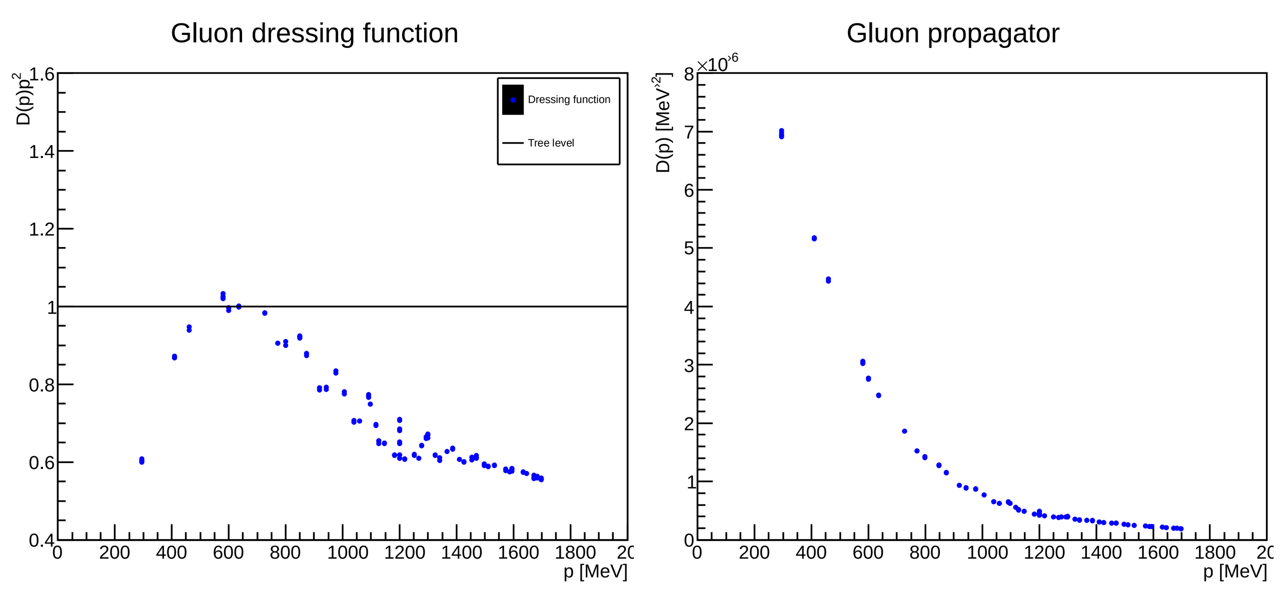
where

$$F^a_{\mu\nu} = \partial_\mu w^a_\nu - \partial_\nu w^a_\mu + g f^a_{bc} w^b_\mu w^c_\nu$$
$$D^{ik}_\mu = \delta^{ik}\partial_\mu - igw^s_\mu t^{ik}_s$$

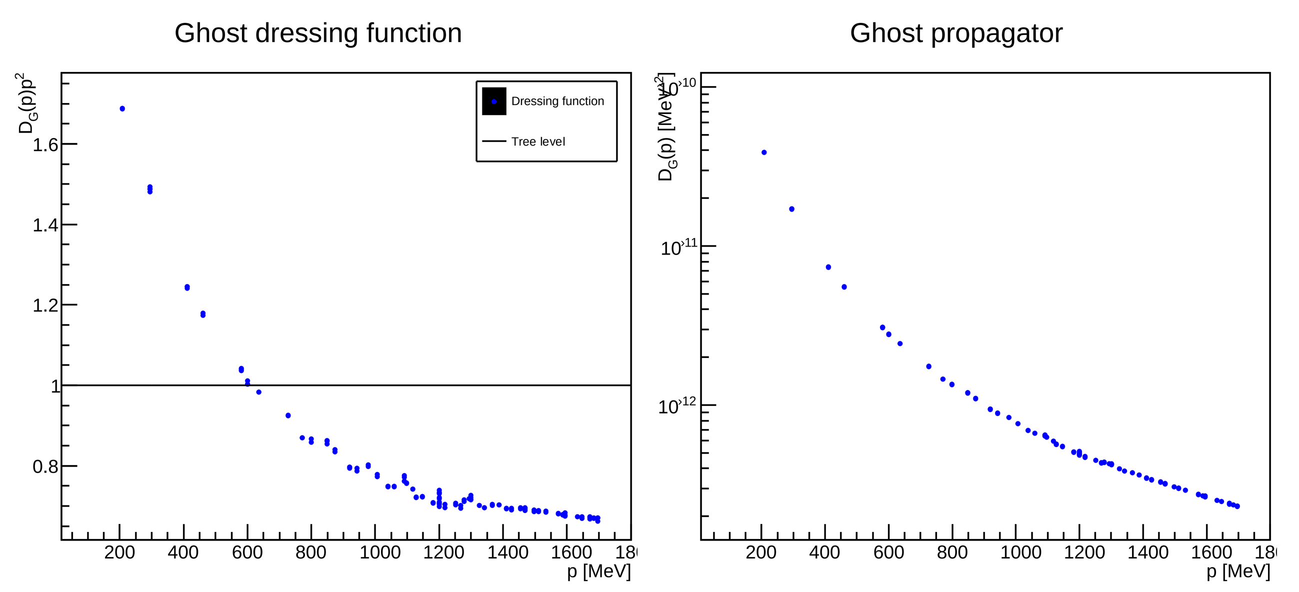
$\lambda = 0$, $g = 1.342$ and $m = 0$ (for lattice version $\beta = 2.221$, $\kappa = 0.125$, $\lambda = 0$)
12^4 lattice has been used for the follwing results. Maximal Landau gauge is used for computation.
Renormalized propagators and vertices[1], with structure $G = \frac{\Gamma^{tree}\Gamma}{\Gamma^{tree}\Gamma^{tree}}$, are presented.



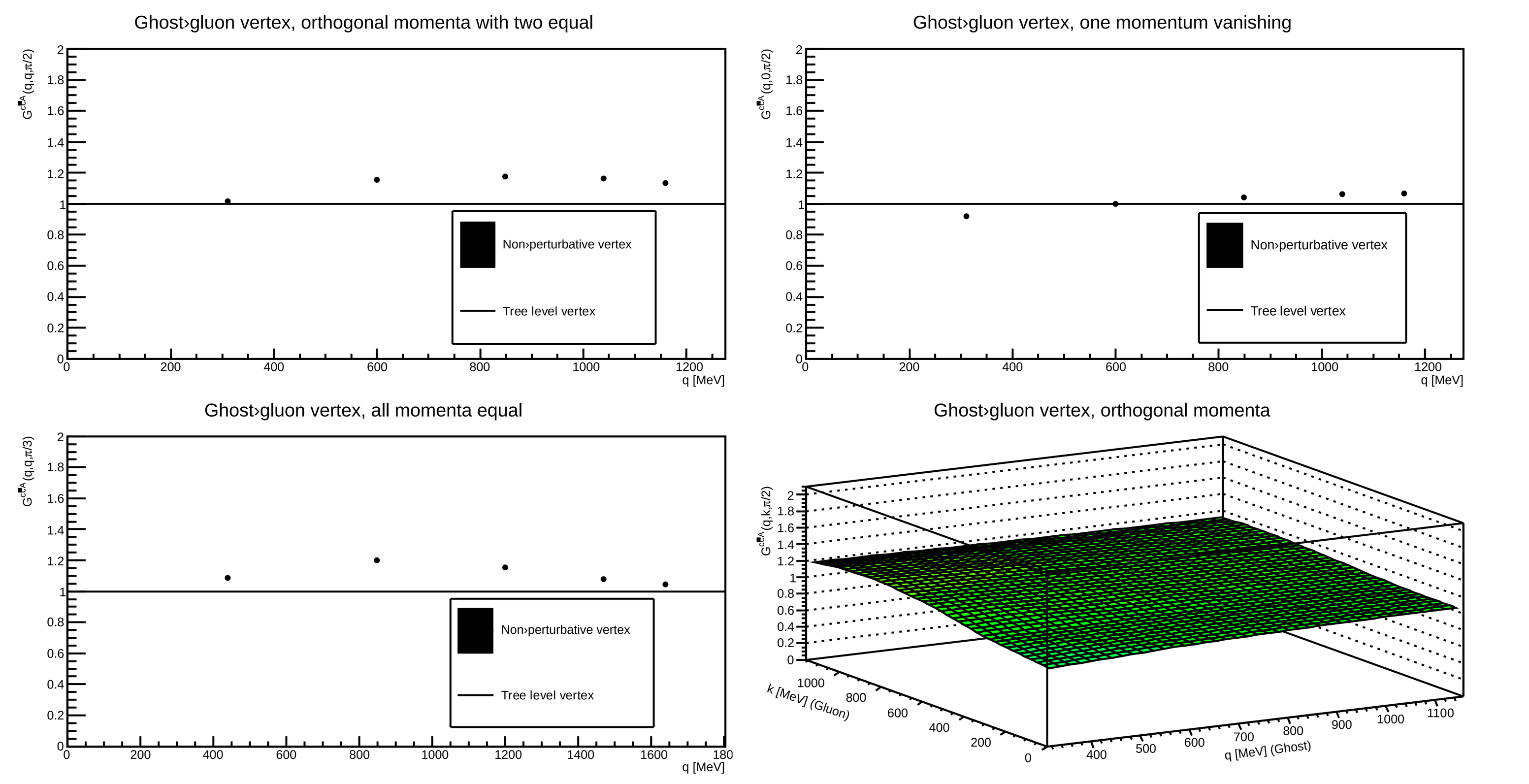
Renormalized Higgs propagator is found to be in agreement with tree level scalar propagator within statistical errors.



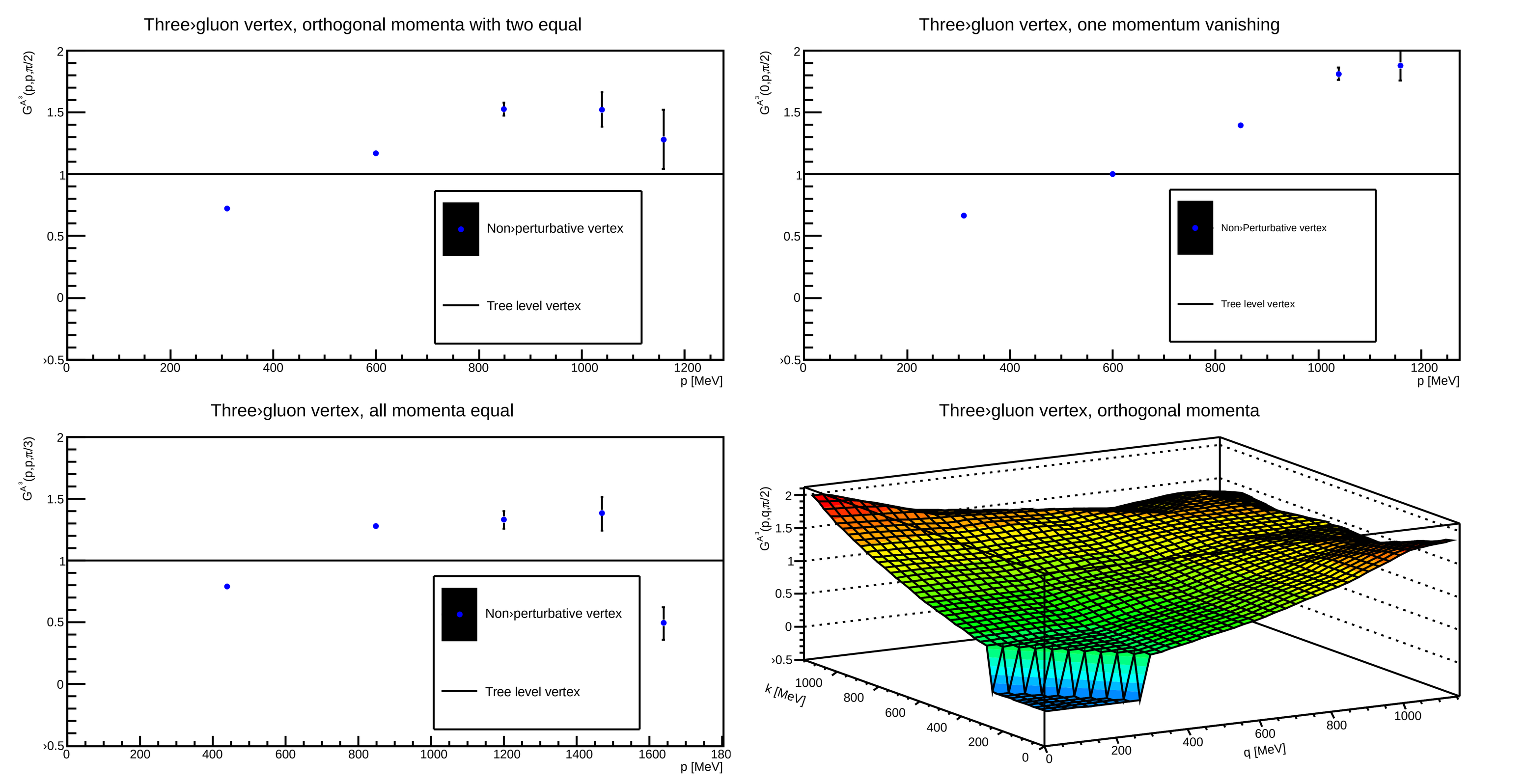
Dressing function of Gluon propagator shows non-trivial non-perturbative contributions.



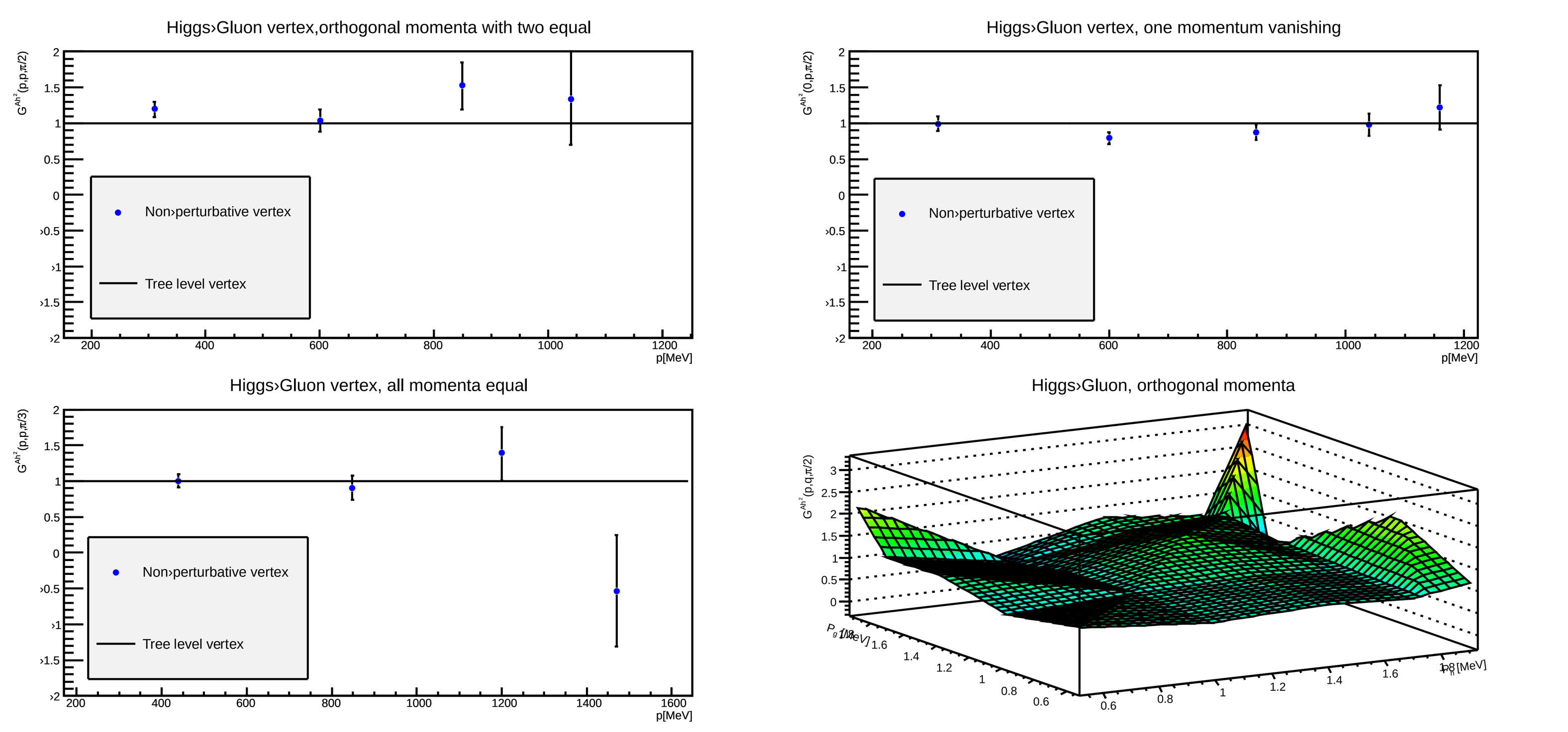
Deviation of the dressing function from tree level is clearly visible, suggesting non-perturbative contributions.



Ghost-gluon vertices appear to be infrared suppressed, deviation from tree level vertices is clearly visible.



Three gluon vertices appear to be infrared suppressed. Deviation from tree level vertices is clearly visible.



Higgs-gluon vertices[2] are found to be in agreement with tree level vertices.

Renormalized Higgs propagator is found to be in agreement with tree level scalar propagator while Gluon and Ghost propagators clearly show non-perturbative contributions.
Higgs-gluon vertices, for both settings of momentum, appear to be in agreement with tree level vertices, however the rest of the vertices in the theory have indication of infrared suppression, and non-perturbative contributions because of deviation from tree level vertices.
Statistics for bigger lattices are being collected which, so far, support the results shown here.

1. A. Cucchieri, A. Maas, and T. Mendes, Phys.Rev. D74 (2006) 014503, arXiv: 0605011v1
2. A. Maas, T. Mufti, C12-07-04, arXiv: 1211.5301

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