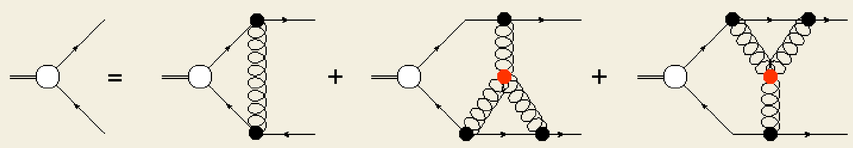
Nonperturbative gluonic three-point correlations

A. Blum[†], M. Q. Huber[‡], M. Mitter[||], L. von Smekal[†*]

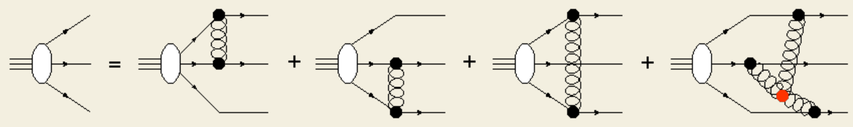
[†]Institut für Kernphysik, Technische Universität Darmstadt [‡]Institut für Physik, Karl-Franzens-Universität Graz
[||]Institut für Theoretische Physik, Universität Heidelberg [*]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen

Relevance of gluonic three-point correlations

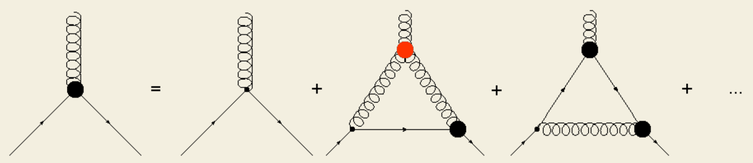
- Mesons: beyond rainbow-ladder



- Hadrons



- Quark-gluon vertex

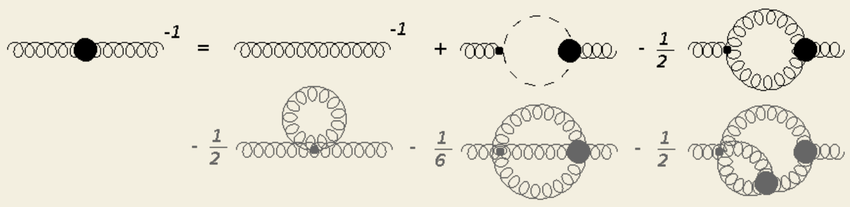


→ quark propagator, technicolor, phase diagram, …

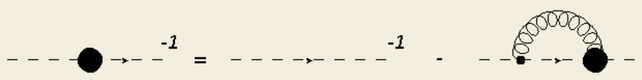
- **QCD phase diagram**
  → functional methods applicable at non-vanishing density

Propagators and ghost-gluon vertex [1]

Gluon propagator: $D_{\mu\nu}(p) = \left(g_{\mu\nu} - \frac{p_\mu p_\nu}{p^2}\right)\frac{Z(p^2)}{p^2}$



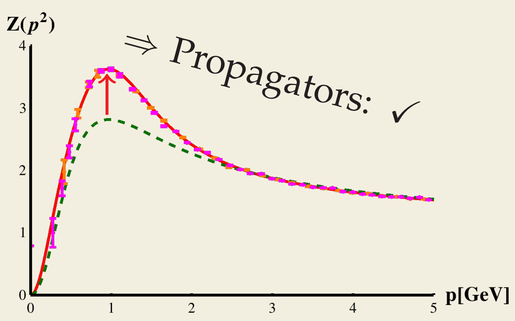
Ghost propagator: $D(p) = -\frac{G(p^2)}{p^2}$



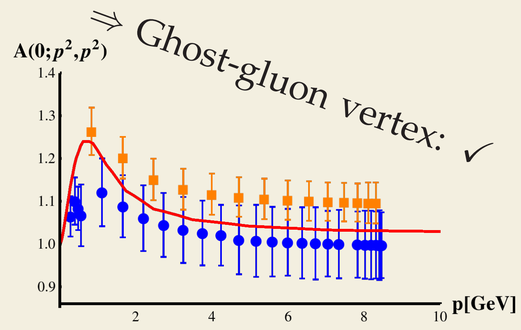
Ghost-gluon vertex:

$$\Gamma^{A\bar{c}c,abc}_{\mu}(k,p,q) = i\,g\,f^{abc}\left(A(k^2,p^2,\alpha)p_\mu + B(k^2,p^2,\alpha)k_\mu\right)$$

Three-gluon vertex:
Optimized effective three-gluon vertex → Closes gap (red curve).



⇒ Propagators: ✓

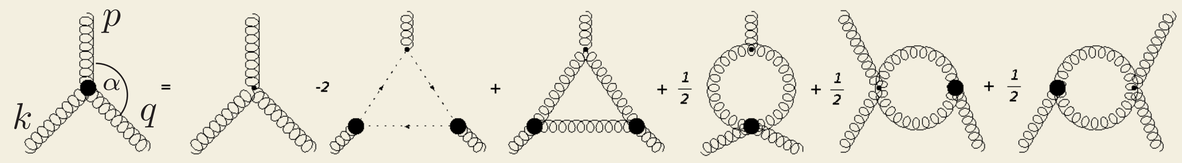


⇒ Ghost-gluon vertex: ✓

lattice data: [2]

Three-gluon vertex

Truncated DSE:

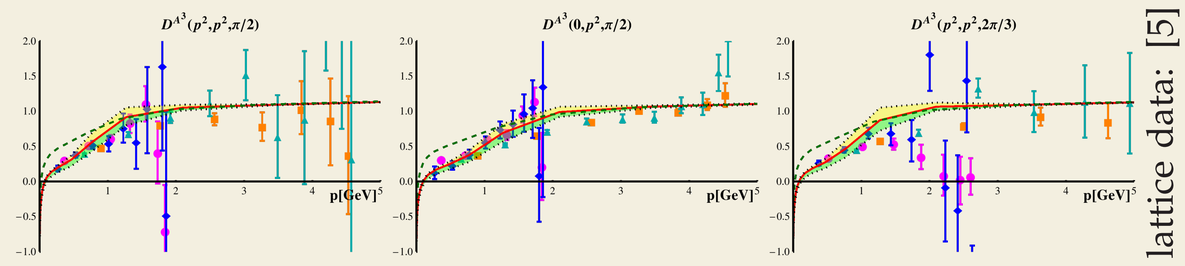


Basis approximation by one tensor:

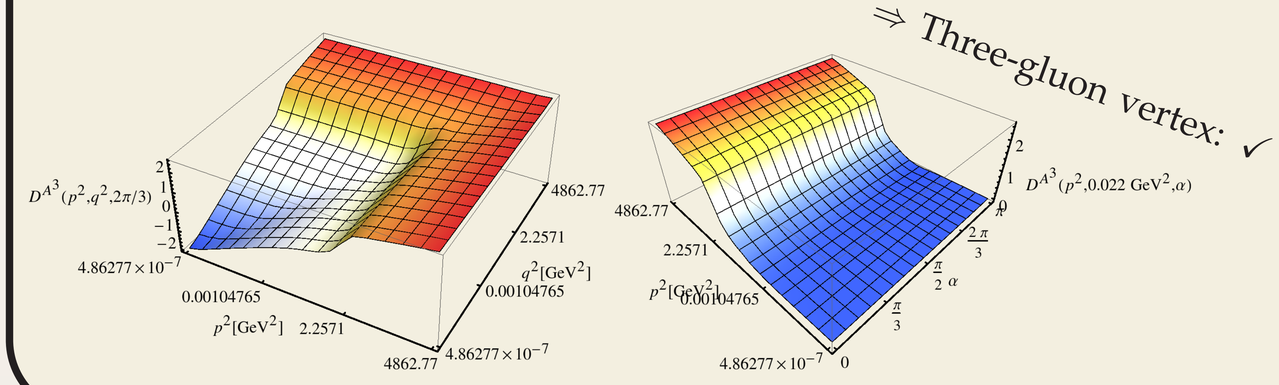
$$\Gamma^{A^3,abc}_{\mu\nu\rho}(p,q,k) = i\,g\,f^{abc}D^{A^3}(p^2,q^2,\alpha)\left((q-p)_\rho g_{\mu\nu} + perm.\right)$$

Other dressings extremely small [3].

Results for $D^{A^3}(p^2,q^2,\alpha)$ [4]:



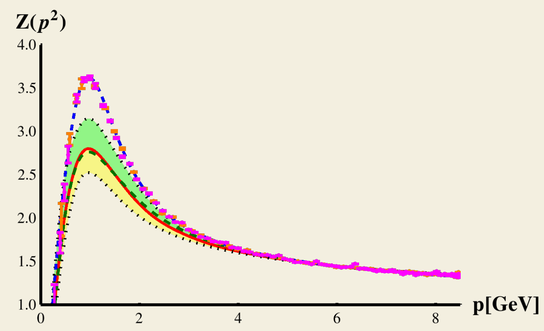
lattice data: [5]



⇒ Three-gluon vertex: ✓

Two-loop effects

Input: Lattice equivalent ghost-gluon and three-gluon vertices.

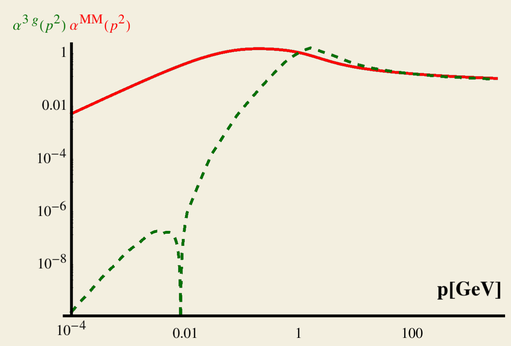


Correct vertices do not close the gap.
⇒ Two-loop diagrams important.

Running couplings

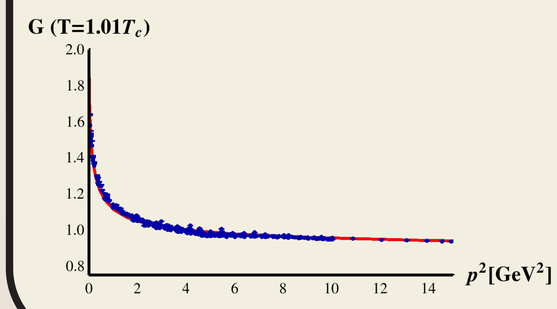
$$\alpha^{\mathrm{MM}}(p^2) = \alpha(\mu^2)Z(p^2)G(p^2)^2$$

$$\alpha^{3g}(p^2) = \alpha(\mu^2)\frac{Z(p^2)^3 D^{A^3}\left(p^2,p^2,2\pi/3\right)^2}{Z(\mu^2)^3 D^{A^3}\left(\mu^2,\mu^2,2\pi/3\right)^2}$$

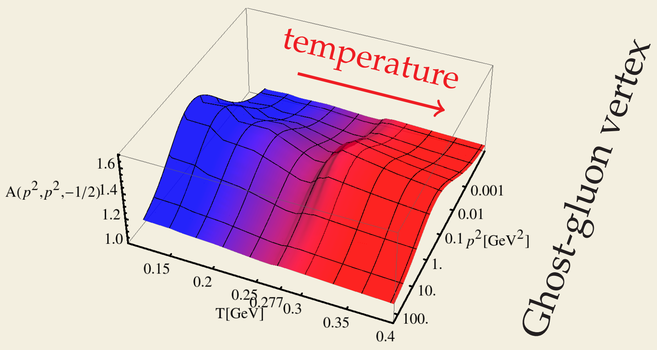


Non-zero temperature [6]

Ghost propagator: ✓



lattice data: [7]



Ghost-gluon vertex

Conclusions

- Three-point functions well described by one-loop truncation.
- Two-loop diagrams important for gluon propagator.

> Primitively divergent vertex functions sufficient for a quantitative description.

- Input for calculations of (dual) quark condensates, Polyakov loop potential, … → transitions.

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References

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