Aspects of Yang-Mills Green functions in the infrared

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Summary

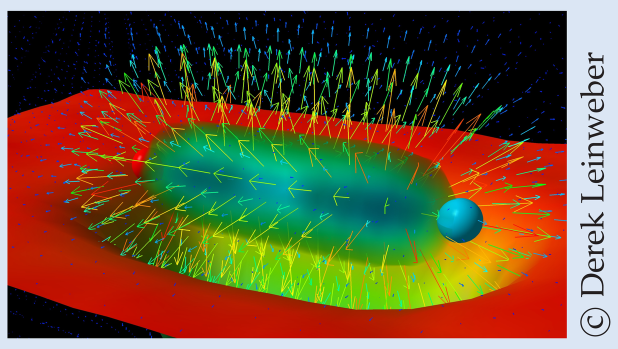
Green functions give access to the properties of the QCD phase diagram (→ see contributions by Alkofer, Fischer, Fister, Haas, Lücker, Maas, Müller-Preussker, Pawlowski, Reinhardt, Schaefer, and others). A prerequisite for the current developments has been the growing understanding of Green functions in the vacuum.

Here we show results in the so-called **maximally Abelian gauge** that support the hypothesis of Abelian infrared dominance. Furthermore, details of the **three-point vertices in the Landau gauge**, which are, for example, required for calculations of glueballs and a next-generation truncation, are presented.

Maximally Abelian gauge (MAG)

Abelian infrared dominance

Dual superconductor picture of confinement (Mandelstam, 't Hooft):
Confinement caused by chromomagnetic monopoles which squeeze chromoelectric flux into flux tubes.



Monopoles ∈ Abelian subalgebra ⇒ hypothesis of Abelian infrared (IR) dominance [1]

Investigate Abelian IR dominance with functional RG equations and Dyson-Schwinger equations.

Gauge fixing

Split the gauge field into
→ diagonal and
→ off-diagonal parts:

$$A_\mu = A^i_\mu T^i + B^a_\mu T^a$$

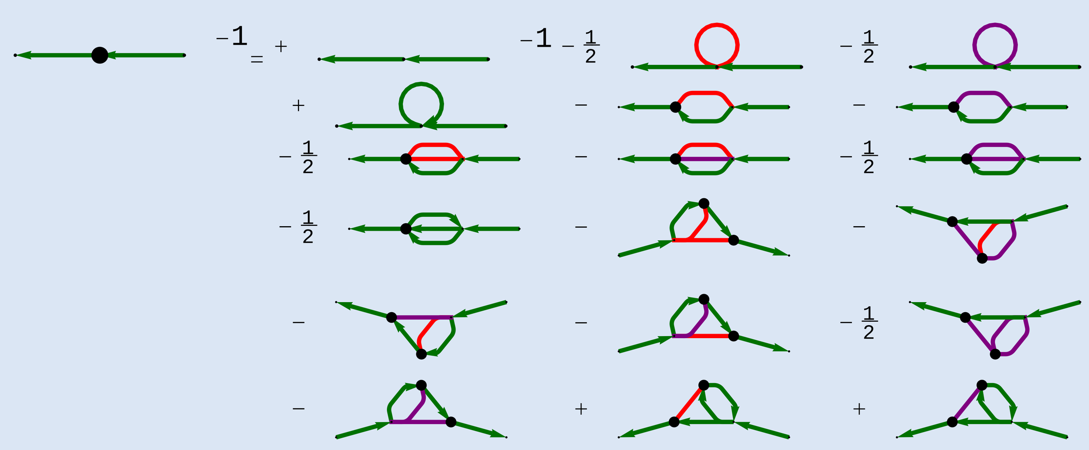
Minimize $||B||$ ⇒ maximally Abelian gauge with gauge fixing parameter α:

$$D^{ab}_\mu B^a_\mu = 0$$

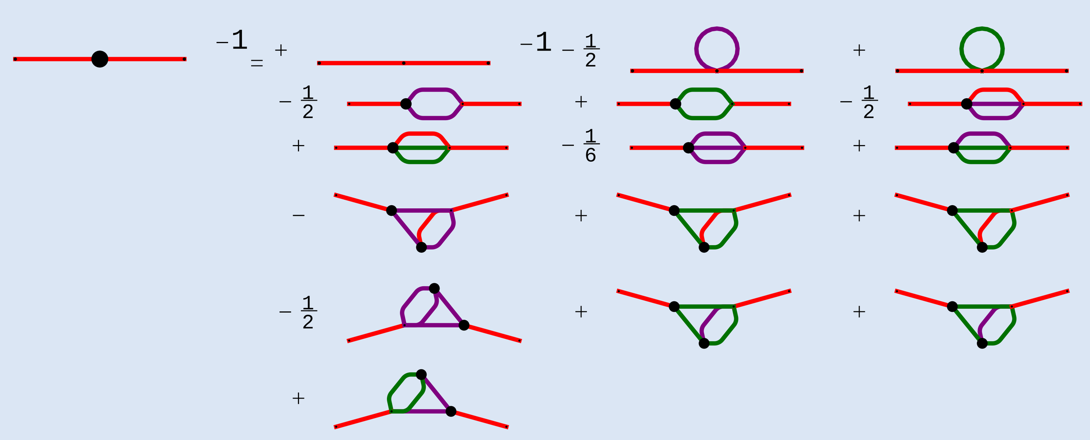
Ghosts: quartic interactions with gluons and among themselves

Functional equations

DSE of the ghost two-point function:



DSE of the diagonal gluon two-point function:



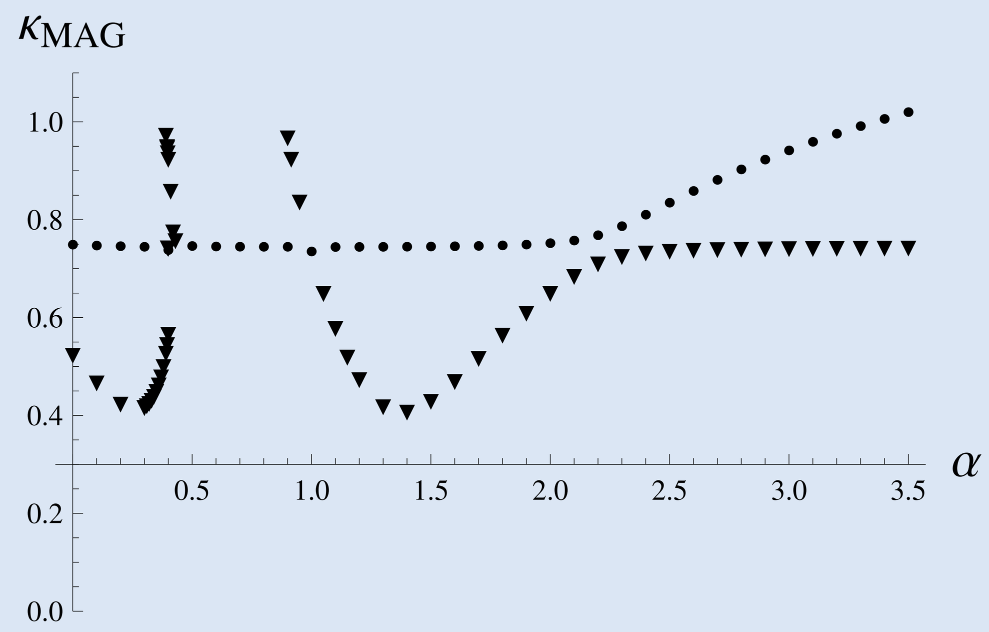
Infrared solution of the MAG [2]

Propagators in the IR characterized by power laws:

$$D_A(p^2) = d_A(p^2)^{-\kappa_A-1},\ D_B(p^2) = d_B(p^2)^{-\kappa_B-1},$$
$$D_c(p^2) = d_c(p^2)^{-\kappa_c-1}$$

- analysis of the *complete* towers of equations (DSEs and RGEs)
- diagonal gluon propagator $D_A(p^2)$ IR enhanced
  ⇒ Abelian degrees of freedom dominate in the IR
- off-diagonal propagators IR suppressed
- unique scaling relation between IR exponents: $\kappa_{MAG} = \kappa_A = -\kappa_B = -\kappa_c$

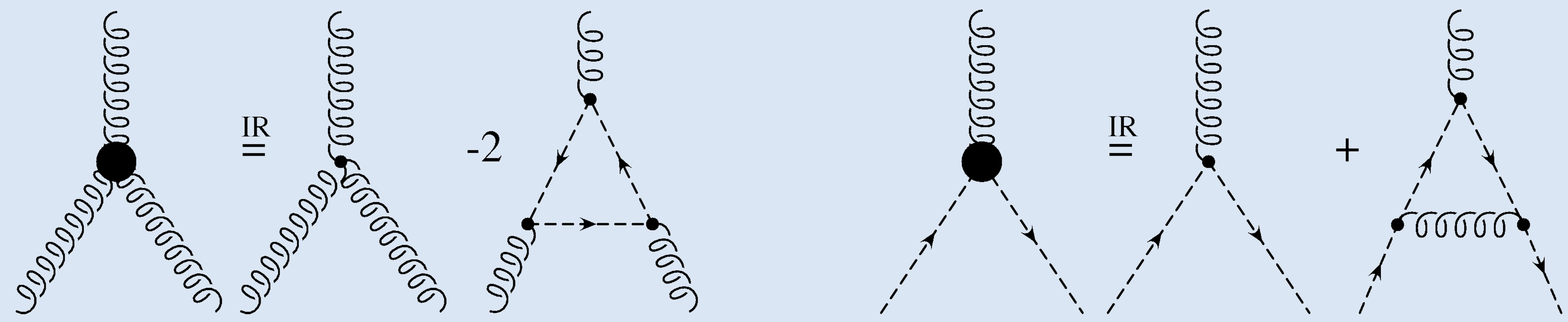
Scaling exponent κ_{MAG} is independent of gauge fixing parameter α:



All calculations used *DoFun* [3].

Three-point vertices in the Landau gauge [4]

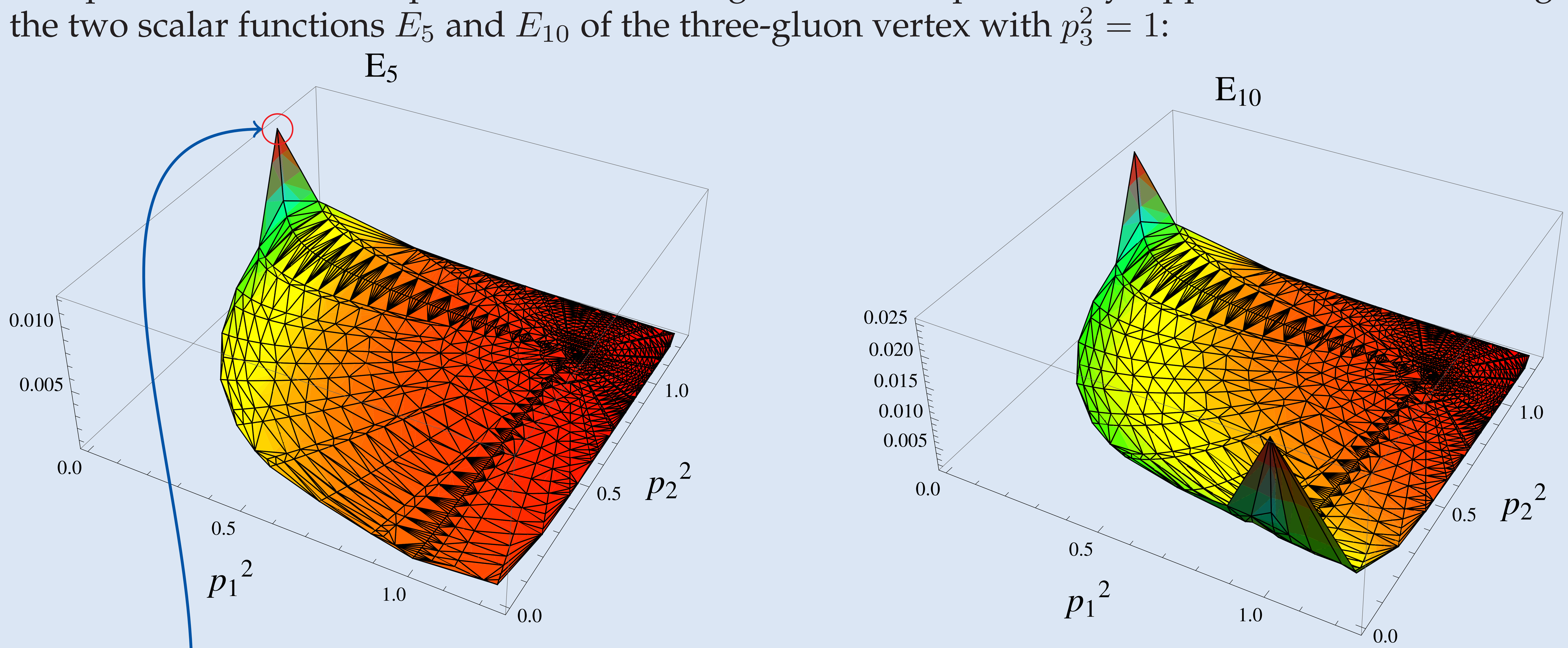
Truncated DSEs of the three-gluon and the ghost-gluon vertices:



The IR solution for the three-gluon vertex has ten dressing functions $E_i(p_1,p_2,p_3)$:

$$\Gamma^{gh-\Delta}_{\mu\nu\rho}(p_1,p_2,p_3) = \sum_{i=1}^{10} E_i(p_1,p_2,p_3)\tau^i_{\mu\nu\rho}(p_1,p_2,p_3).$$

Complete momentum dependence of dressing functions expressed by Appell's functions F_4, e. g. the two scalar functions E_5 and E_{10} of the three-gluon vertex with $p_3^2 = 1$:



Kinematic singularities (e. g. $p_3^2 = p_2^2,\ p_1^2 \to 0$) going like $(p^2)^{1-2\kappa}$ found only in longitudinal parts [4], cf. also ref. [5].
Three-point functions may have a quantitative but not a qualitative impact on propagators.

References

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