The Vertex Function of Fundamental Scalar Charges in Landau QCD

Diploma Thesis

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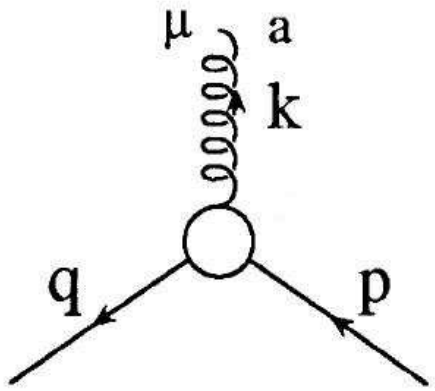
Motivation

Quark-Gluon Vertex in QCD



General Structure

$$\Gamma^a_\mu(k,q,p) = -igt^a(2\pi)^4\delta^4(k+q-p)\Gamma_\mu(q,p)$$

12 Tensor Structures

Relation to Quark Confinement see talk by Kai Schwenzer

Idea of Fundamental Scalar Charges

- Quarks $\longrightarrow$ Fundamental Scalar Charges
- Theory gets easier to handle
- reduce Number of Tensor Structures
- Confinement by the Vertex ?

Idea of Fundamental Scalar Charges

- Dyson-Schwinger Equations
- Infrared Analysis, IR Fixed Points
- Confinement ? (cf. Adjoint Charges)
- Numerical Solution of the Vertex
- Check with Lattice Calculations

Idea of Fundamental Scalar Charges

Lagrangian

$$\mathcal{L} = \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{c}^a \partial_\mu D^{\mu,ab} c^b + \frac{1}{2}(D^\mu_{ij}\phi^*_j)(D_{\mu,ik}\phi_k) - \frac{1}{2}m^2\phi^*_i\phi_i - \frac{\lambda}{4!}(\phi^*_i\phi_i)^2$$

$$\phi_i : \ i = 1, \ldots, N \ (SU(N))$$

$$D^{\mu,ab} = \partial^\mu \delta^{ab} - g f^{abc} A^{\mu,c}$$

$$D^\mu_{ij} = \partial^\mu \delta_{ij} - ig(\frac{t^a}{2})_{ij} A^{\mu,a}$$

Formalism

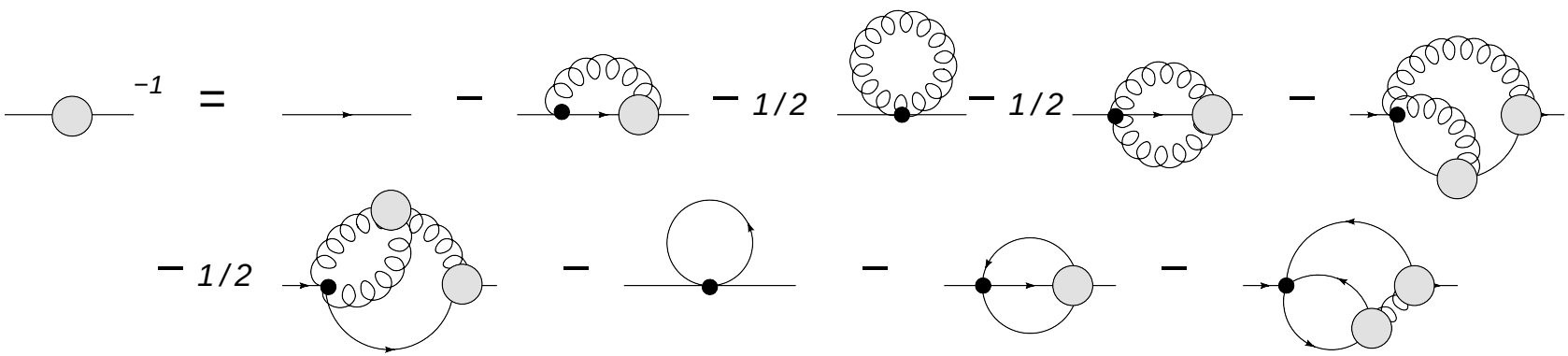
Non-Perturbative Functional Method: *Dyson-Schwinger Equations*

$$\frac{\delta\Gamma[\phi]}{\delta\phi_i} - \frac{\delta S}{\delta\phi_i}\left[\phi + \frac{\delta^2 W}{\delta j \delta j}\frac{\delta}{\delta\phi}\right] = 0$$

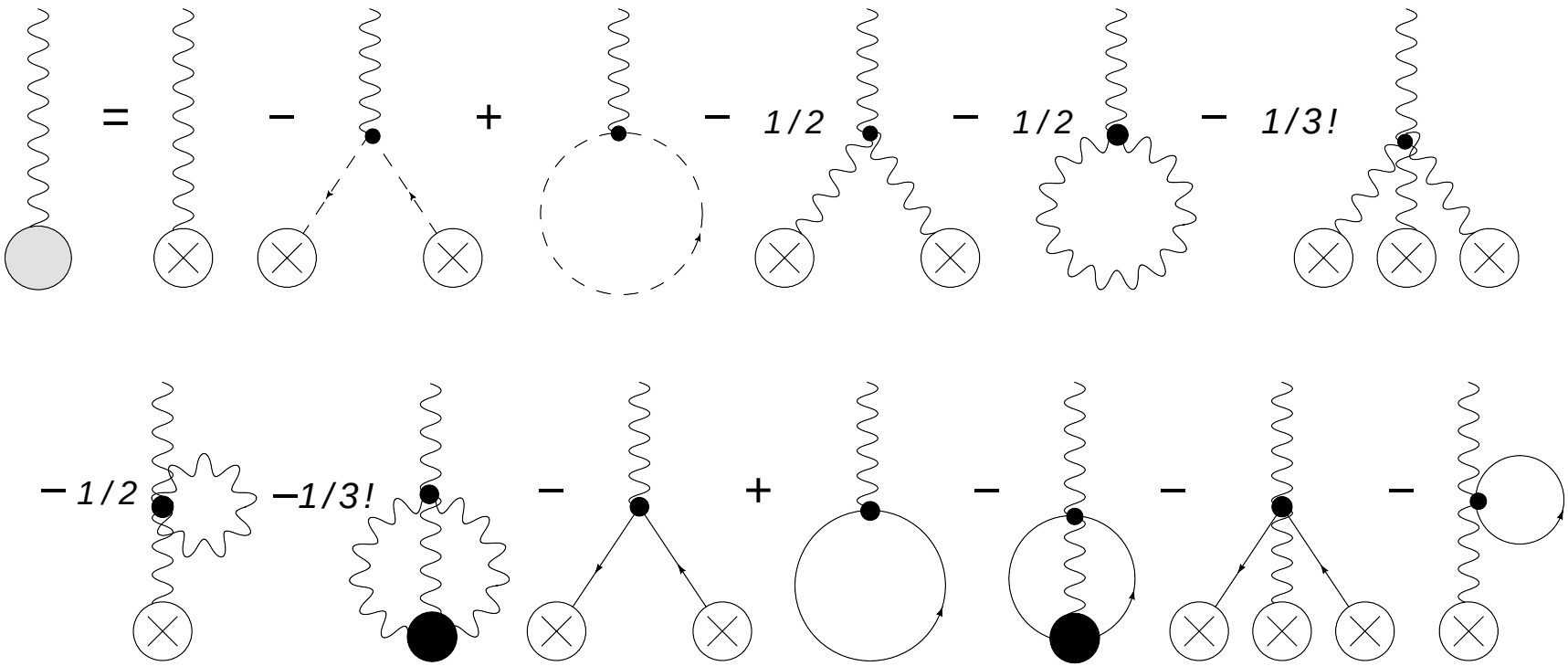
Primitively Divergent Graphs:

$$D_s,\ D_g,\ D_{gh},\ \Gamma^{3g},\ \Gamma^{4g},\ \Gamma^{2s,g},\ \Gamma^{2s,2g},\ \Gamma^{4s},\ \Gamma^{g,gh}$$

Dyson-Schwinger Equation for the Scalar Charge

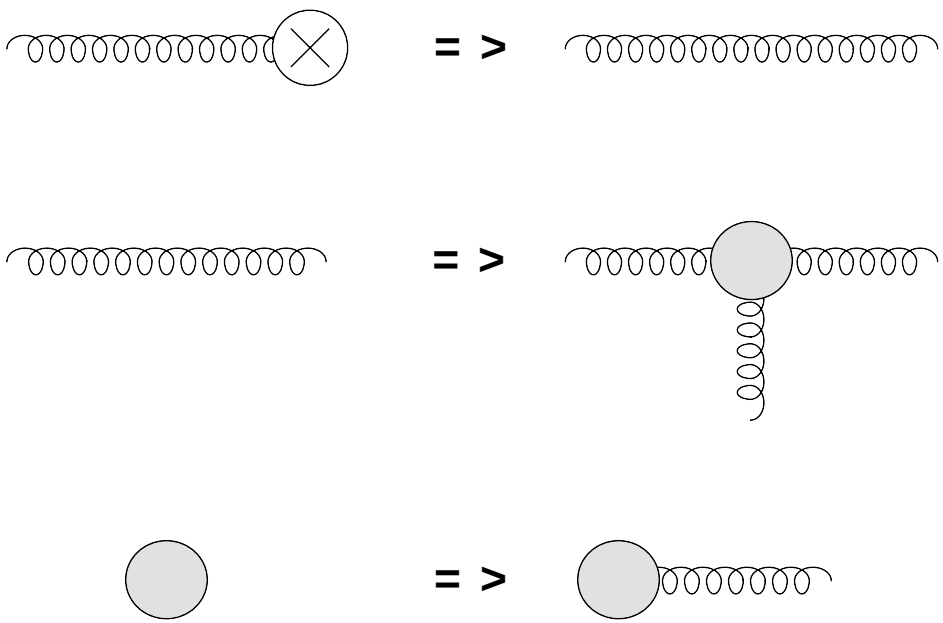


Dyson-Schwinger Equation for the Gluon



Dyson-Schwinger Equation for the Scalar Particle-Gluon Vertex

graphical method:



Outlook

Solve coupled DSE:

- Infrared Behaviour: Qualitative Behaviour in the Infrared, IR-Exponents of the most singular Dressing Functions
- Infrared Fixed Points
- Numerical Solution