Magnetic Fields and Flow Equations

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Motivation

Goal:
Investigate Chiral symmetry breaking in QCD
in the presence of strong magnetic fields

Current status:

Low Energy Models (QM, NJL etc.)

- **Magnetic Catalysis**
- mostly fermionic + mesonic dynamics
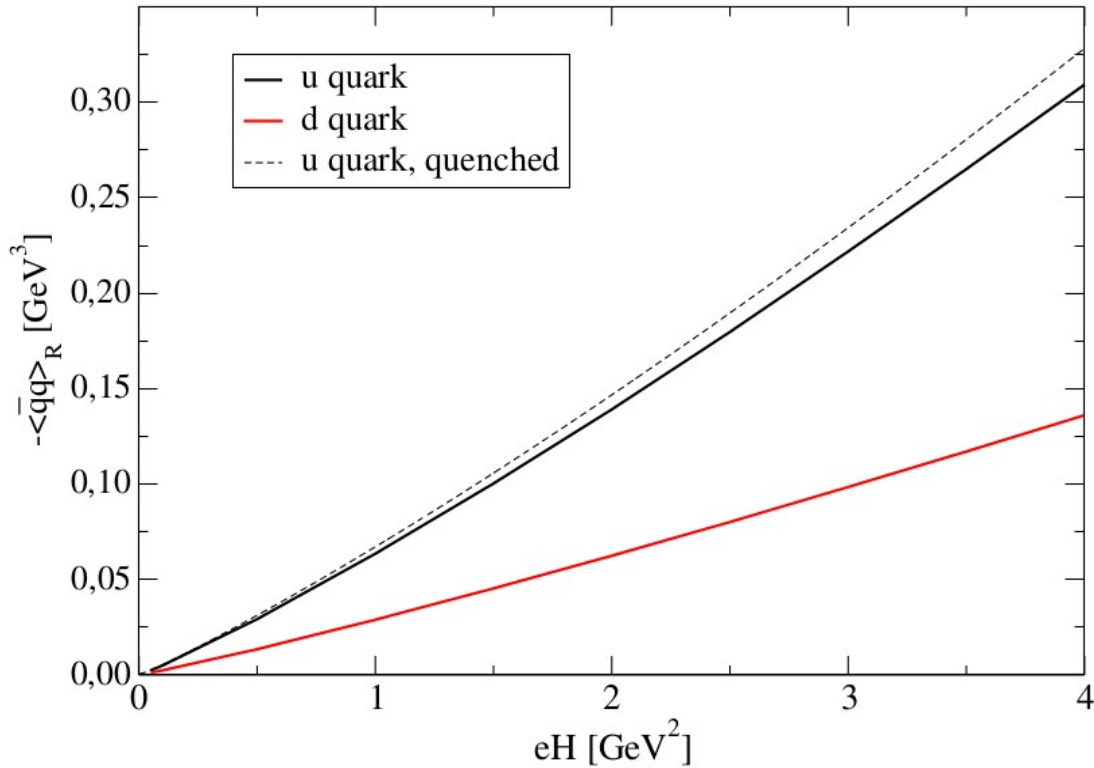- gluons are missing

Lattice QCD

- **Inverse Magnetic Catalysis**

discrepancy!

FRG can bridge QCD and low energy models!

+ lots of other interesting effects and experimental implications!
(CME in HI collisions, Schwinger pair production in strong QED fields, etc.)

Zero T – Magnetic Catalysis

From DSEs:

At zero T in quenched approx. and when unquenching only the lowest landau level:

Magnetic Catalysis can be seen (as expected!)

Goal:

Calculate this at finite T!

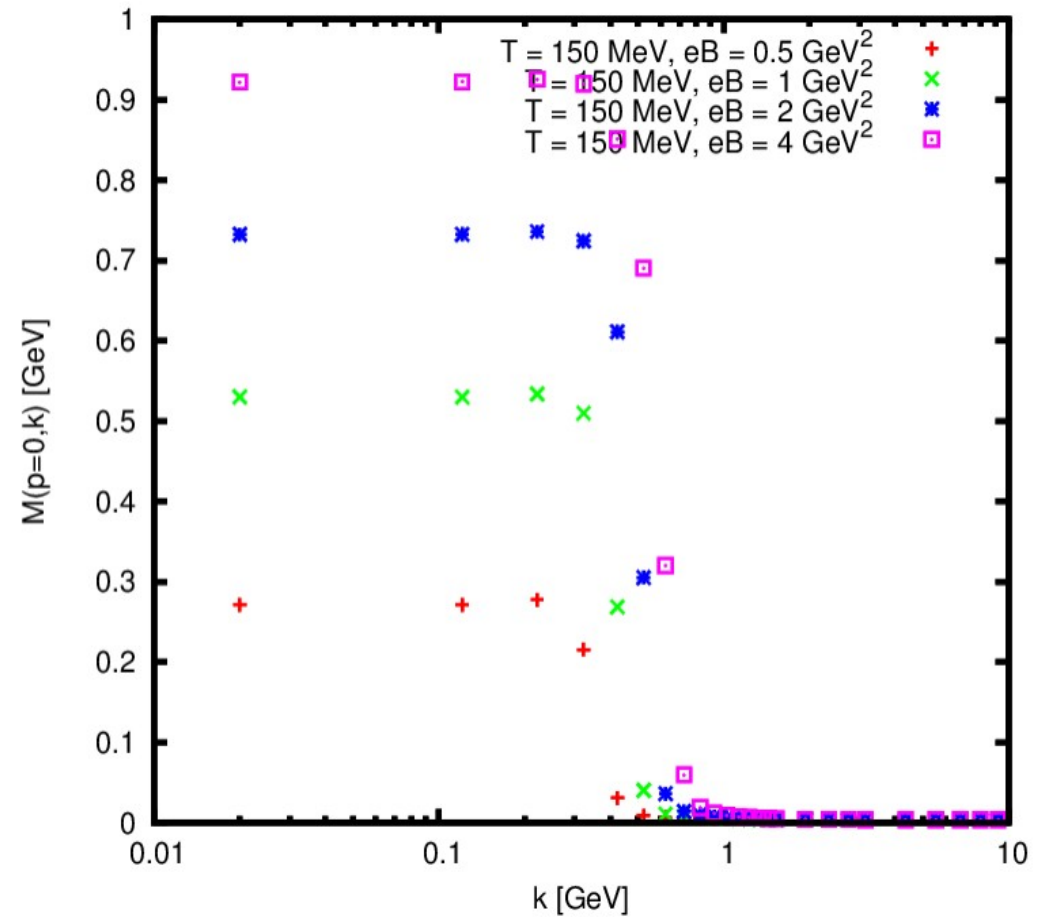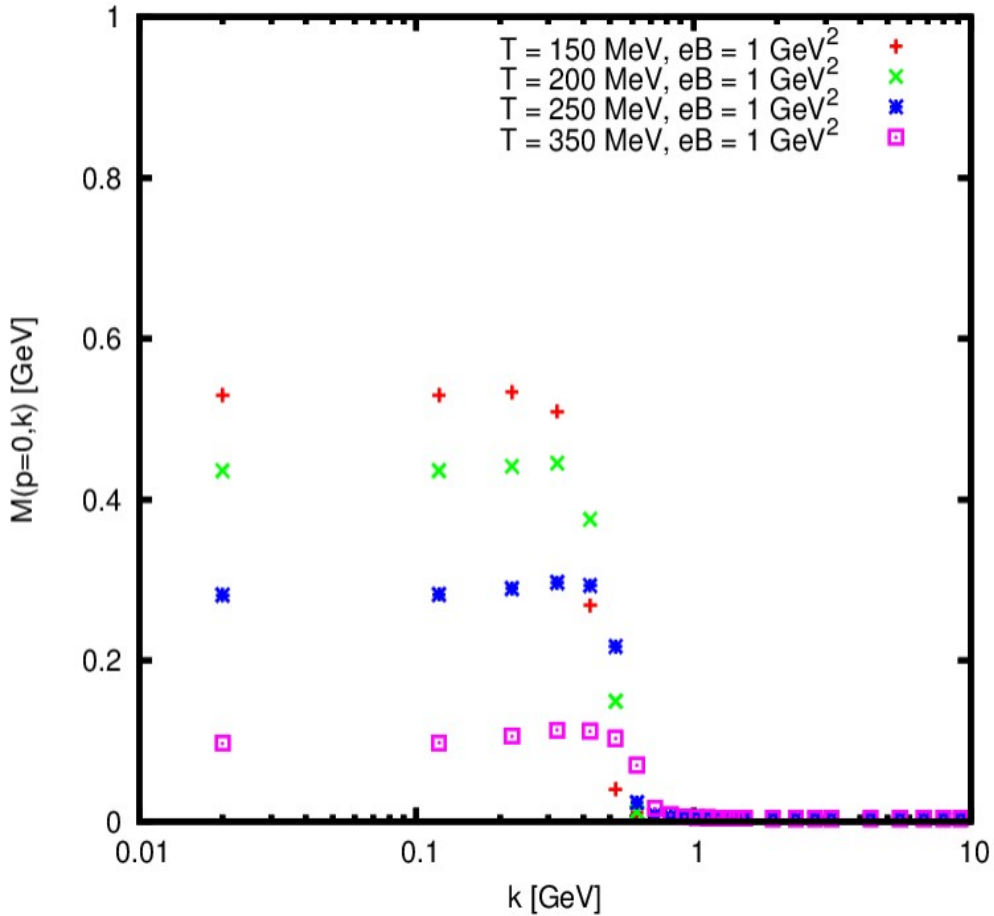Difficult in DSE framework, since quark loop carries (unphysical) quadratic divergences

DSE + FRG = Flow equations for DSEs
→ no divergences!

Finite T and B

lowest landau level approximation at finite T

Outlook: Four Fermi Coupling as indicator for XSB
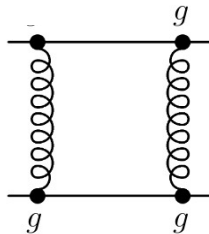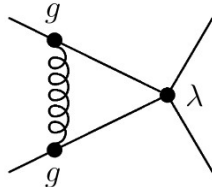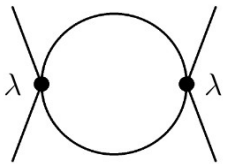
2 flavour QCD at finite T and B

$$S_{\text{QCD}} + \int \mathrm{d}^4 x \; \frac{\lambda}{2} \left[(\bar{\psi}\psi)^2 - (\bar{\psi}\tau^a\gamma_5\psi)^2 \right]$$

Quarks and Gluons

not fundamental, but gluon
induced self interaction

magnetic catalysis:
- critical T rises with B

inverse magnetic catalysis:
- critical T drops with B
(once B strong enough)

$$\partial_t \lambda = c_2 \lambda^2 + c_1 \lambda + c_0$$

finite B: coming soon!