

# The QCD Phase Transition in a Strong Magnetic Background

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## 1 – Goals and Investigation Setup

- **How the QCD phase transition changes in an external magnetic field?**

(see also talks by E. Fraga and A.J. Mizher)

- $T_c(B)$ ?
- Does chiral symmetry restoration and deconfinement get disentangled?
- Does the nature of the transition changes?

- **Our tool: lattice simulations of full QCD**

- two dynamical flavors  $q = 2/3e, -1/3e$ , standard staggered fermions,  $16^3 \times 4$  lattice,  $a \sim 0.3$  fm, various quark masses  $m_\pi \sim 200 \rightarrow 500$  MeV.
- Magnetic field along  $\hat{z}$ , quantized because of periodic boundary conditions,

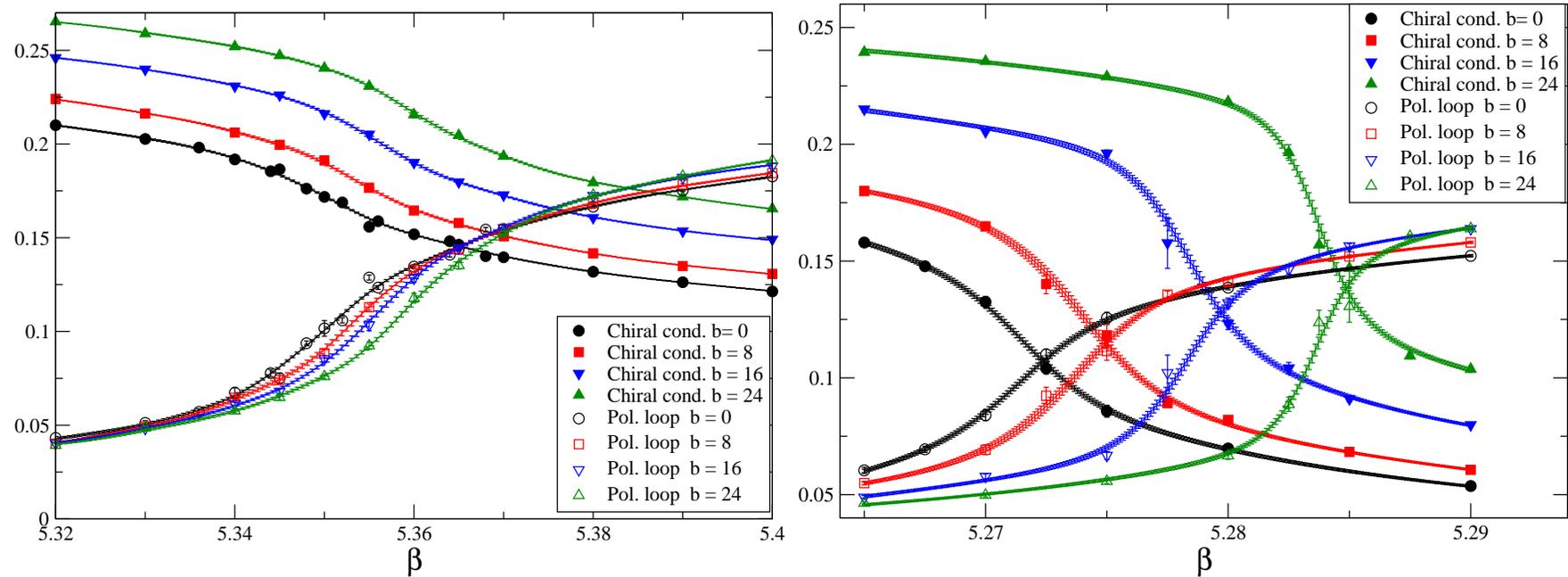
$$qBa^2L_xL_y = 2\pi b$$

$b$  integer,  $q = -1/3e$   $eB \quad b = 0, 8, 16, 24$

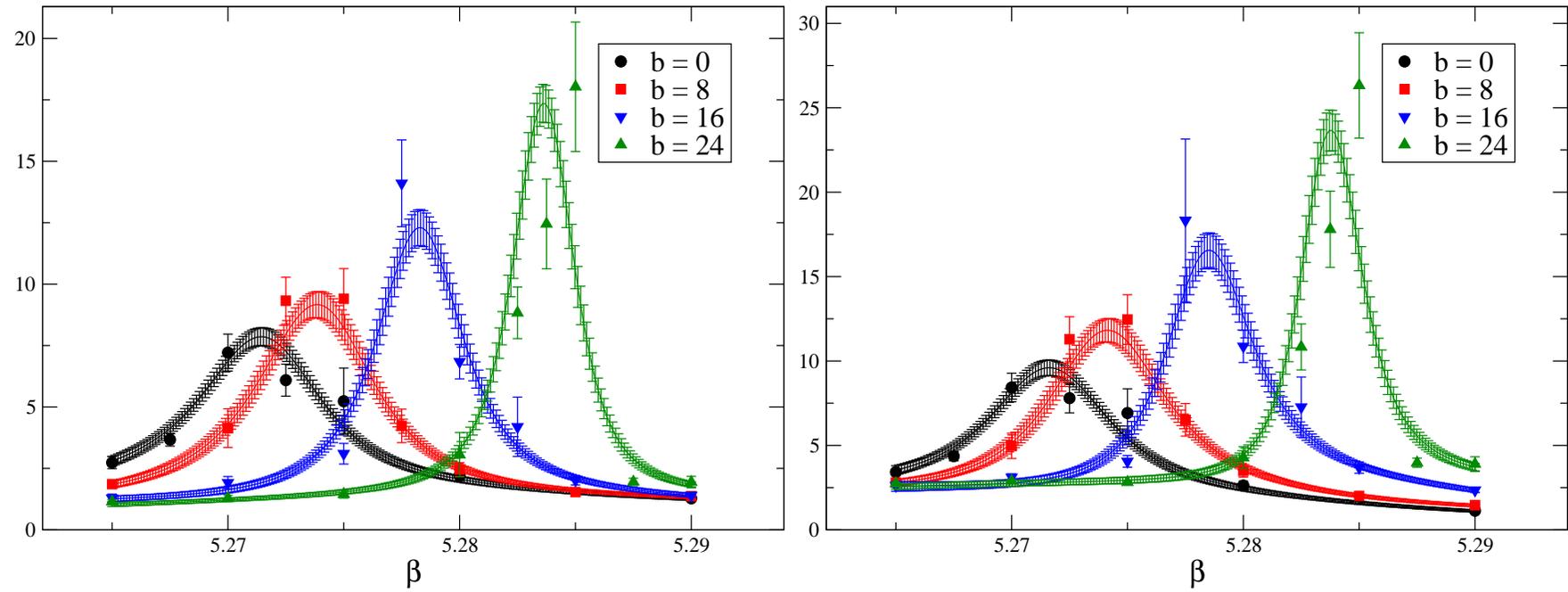
$eB = 6\pi bT^2(N_t/L_s)^2 \implies 0 < eB \in \lesssim (1\text{GeV})^2 \sim 60 m_\pi^2 \sim 10^{16}$  Tesla

- Background  $U(1)$  field added to the Dirac matrix, each flavor treated separately, two different fermion determinants

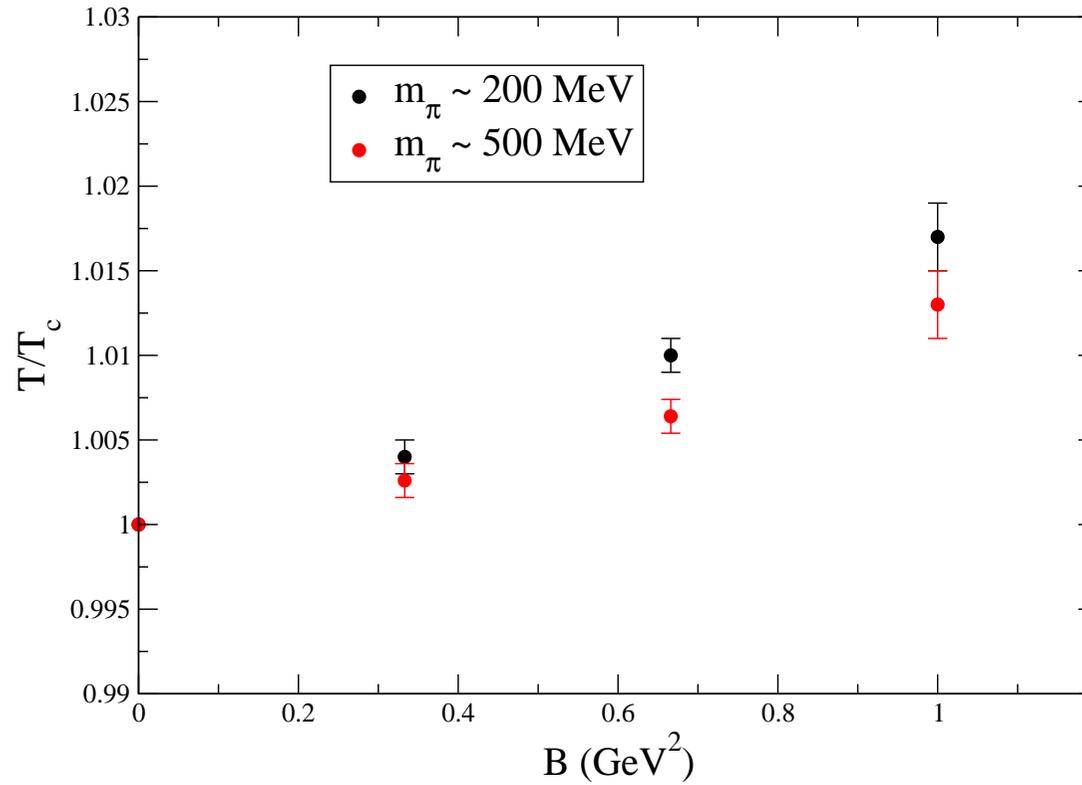
## 2 – Preliminary Results



- Results for the Polyakov loop and chiral condensate at different magnetic fields. The chiral condensate increases, as expected
- $m_\pi \sim 500$  MeV (left) and  $m_\pi \sim 200$  MeV (right)
- $T_c$  increases as  $B$  is increased
- Chiral symmetry restoration and deconfinement move together
- The influence of the magnetic field is more visible at small quark masses
- At the smaller mass the transition clearly strengthens as  $B$  increases



- Polyakov loop susceptibility (left) and disconnected chiral susceptibility (right) at the lower quark mass
- The strengthening of the transition is visible also from the increase of the susceptibilities



- The magnitude of the temperature increase is quite small
- Results are still qualitative: physical scale fixed using the 2-loop  $\beta$ -function. A direct determination of it is in progress.