AdS/CFT with Flavour in Kalb-Ramond Fields

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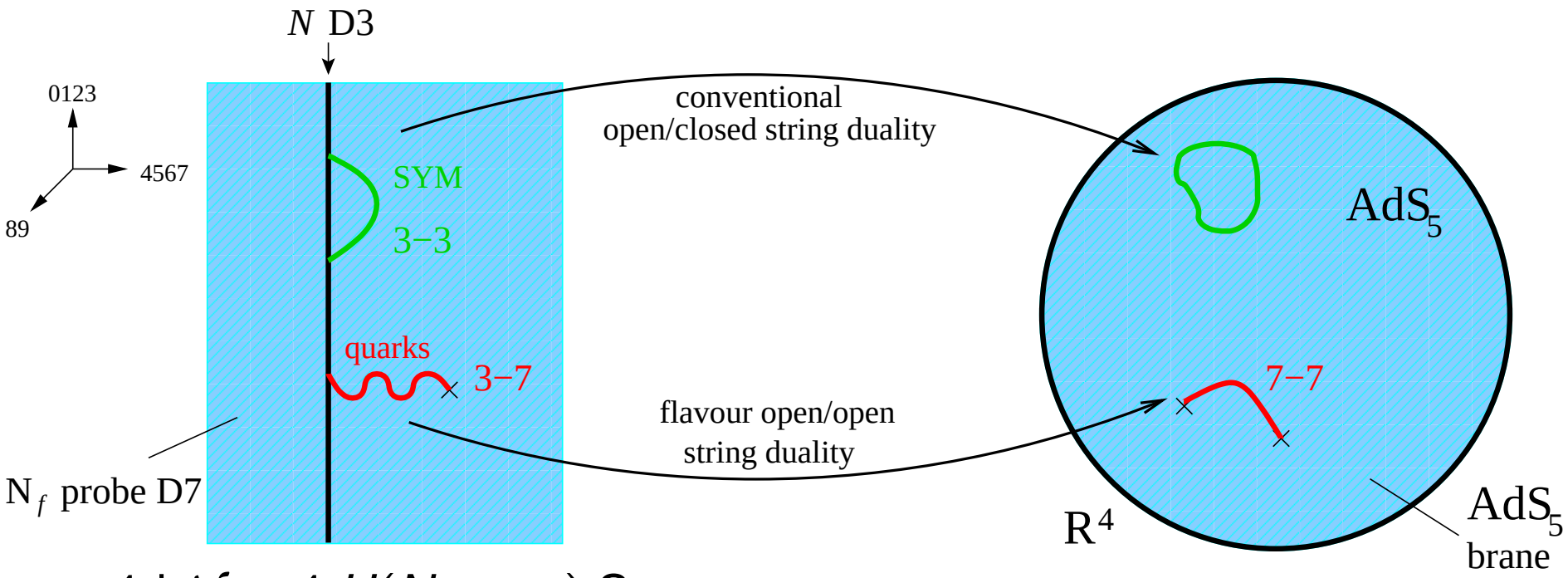
Based on: J. Erdmenger, RM, J. P. Shock, hep-th:0709.1551

[see also hep-th:0709.1547,0709.1554]

Intro: AdS/CFT with quenched flavour



4d $\mathcal{N} = 4$ $U(N \to \infty)$ Super Yang-Mills theory

$(W_\alpha, \Phi_{1,2,3}) = (A_\mu, \lambda_{1,2,3,4}, X^{4,5,6,7,8,9})$

+

$\mathcal{N} = 2$ hypermultiplet

$(Q, \tilde{Q}) = (q, \tilde{q}, \psi, \tilde{\psi})$

$\leftrightarrow$

type IIB SUGRA on $AdS_5 \times S^5$

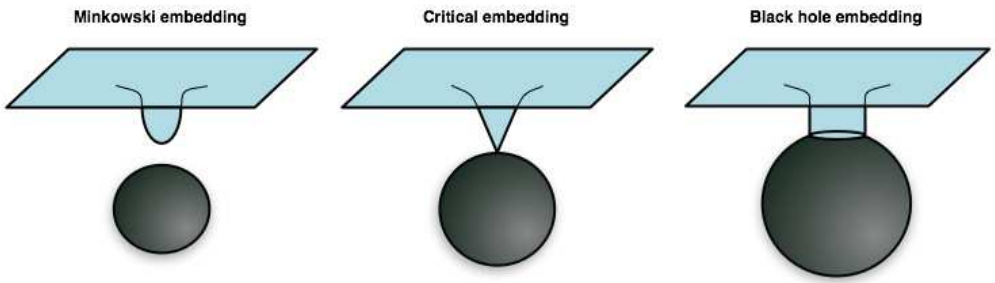
+

Dirac-Born-Infeld theory on $AdS_5 \times S^3$

Finite Temperature & Kalb-Ramond Field

Flavour Physics at Finite Temperature

$$AdS\text{-Schwarzschild} \times S^5 \text{ (Black brane)}\,, \quad T = T_{\text{Hawking}}$$



1. Embedding: $L(\rho) \overset{\rho\to\infty}{\sim} 2\pi\alpha' m_q + \frac{(2\pi\alpha')^3\langle\bar{\psi}\psi\rangle}{\rho^2}$
2. Fluctuations: Mesons with Spin≤ 1

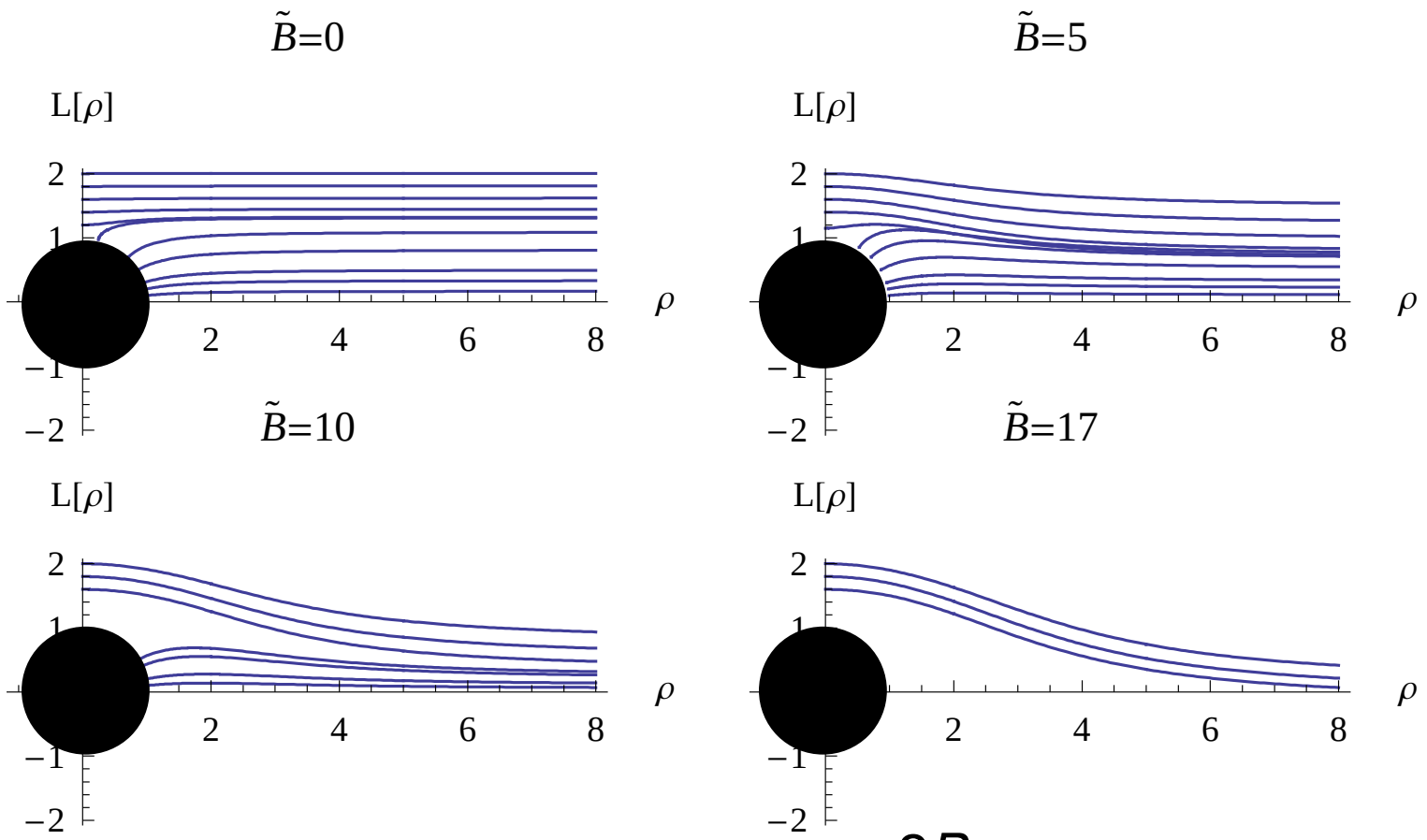
Ansatz for the Kalb-Ramond Field

$$B_{el} = B\mathrm{d}t \wedge \mathrm{d}x\,, \quad B_{mag} = B\mathrm{d}y \wedge \mathrm{d}z$$

- Gauge Theory: Constant electric/magnetic $U(1)$ background

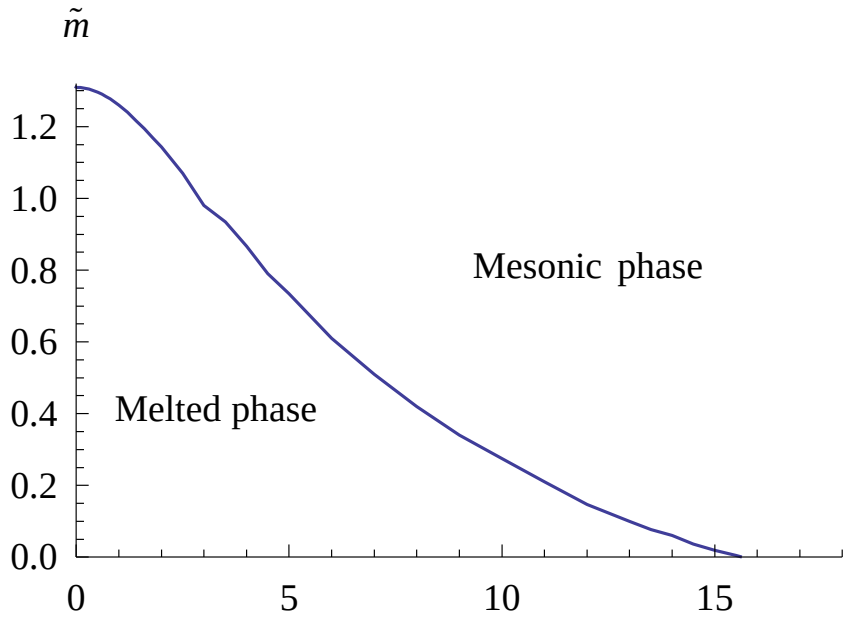
Magnetic Kalb-Ramond Field

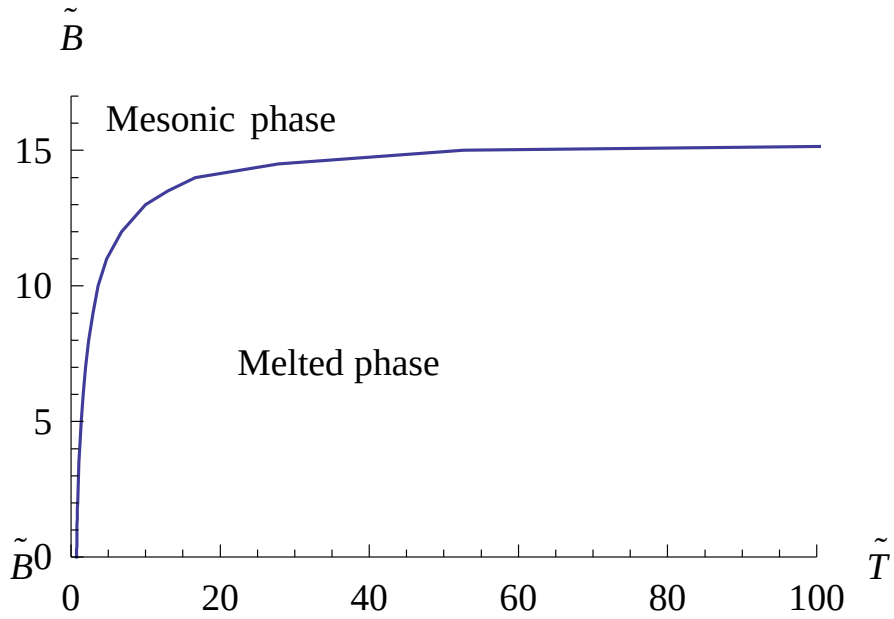
Magnetic Finite Temperature Embeddings



$$\tilde{B}_{crit} \approx 16\,, \quad \tilde{B} = \frac{2B}{(\pi RT)^2}$$

Phase Diagram

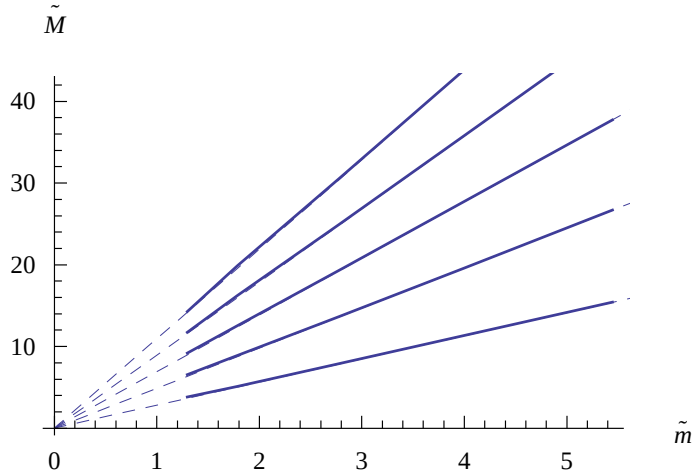




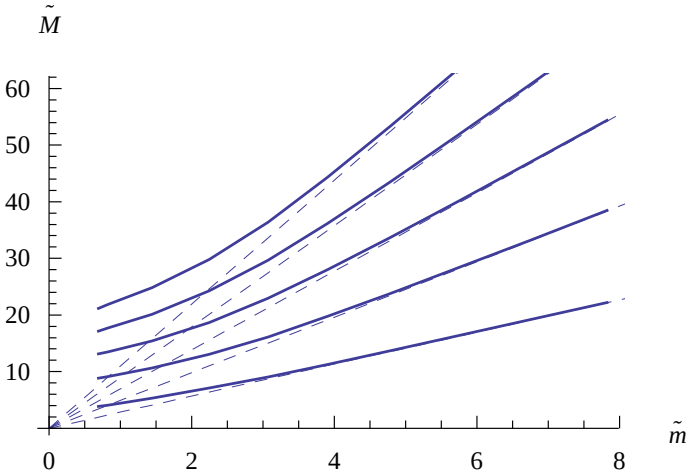
- Meson Melting Transition below $\tilde{B}_{crit}$
- No melted phase and spontaneous CSB above $\tilde{B}_{crit}$
- Magnetic KR-Field acts confining by repelling the D7s from the origin

Pseudoscalar Meson Spectrum & Goldstone Mode of CSB

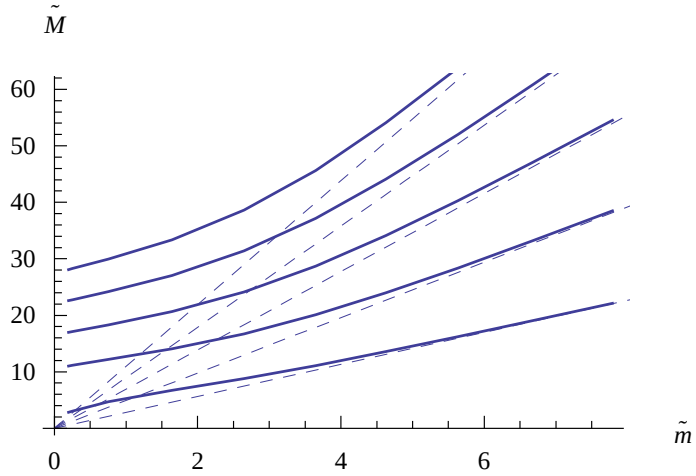
$\tilde{B}$=0



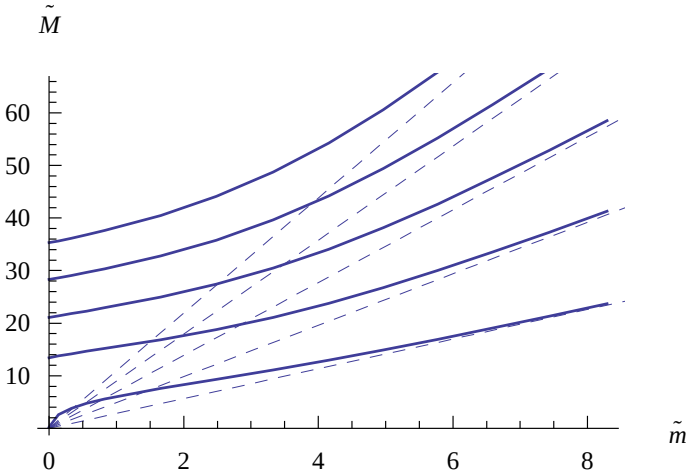
$\tilde{B}$=5



$\tilde{B}$=10



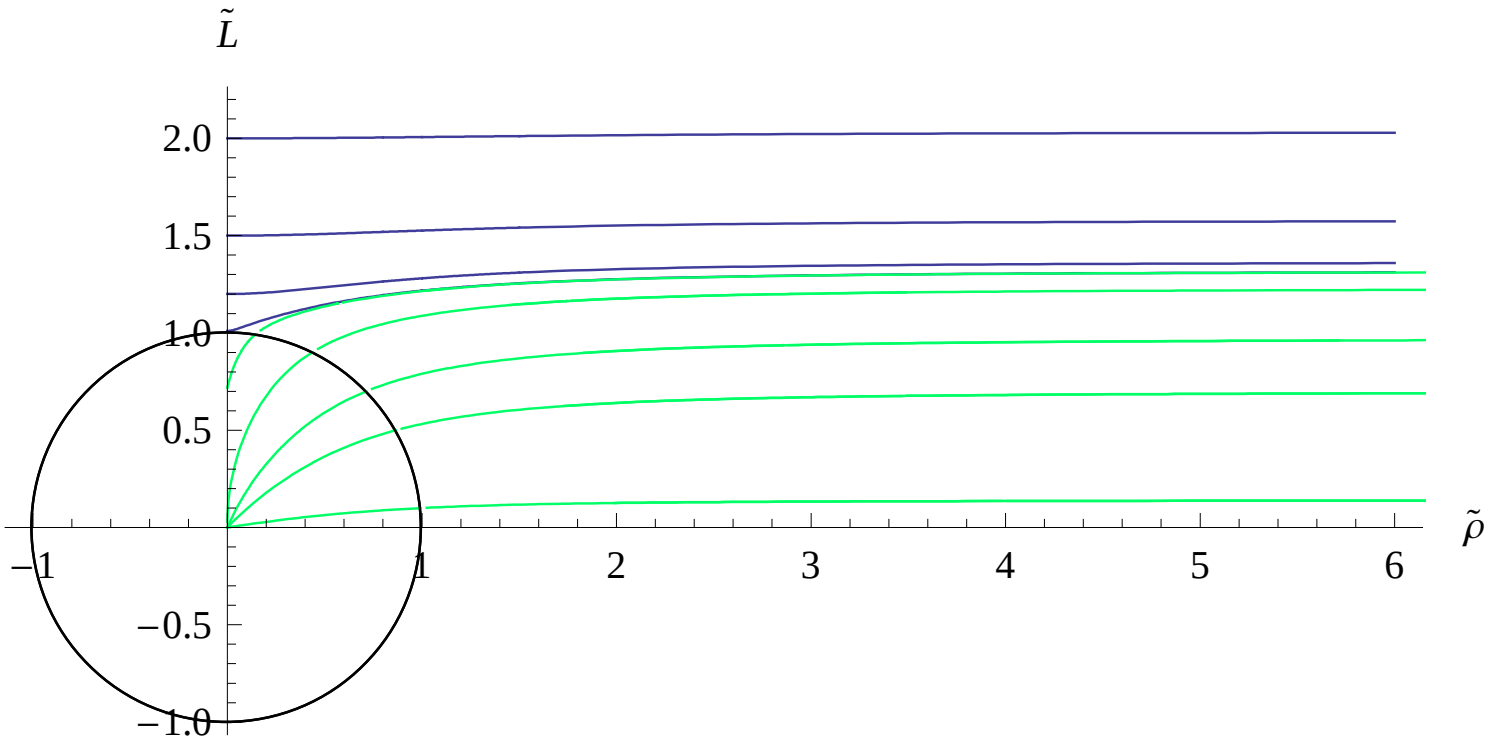
$\tilde{B}$=17



Electric Kalb-Ramond Field @ Zero Temperature

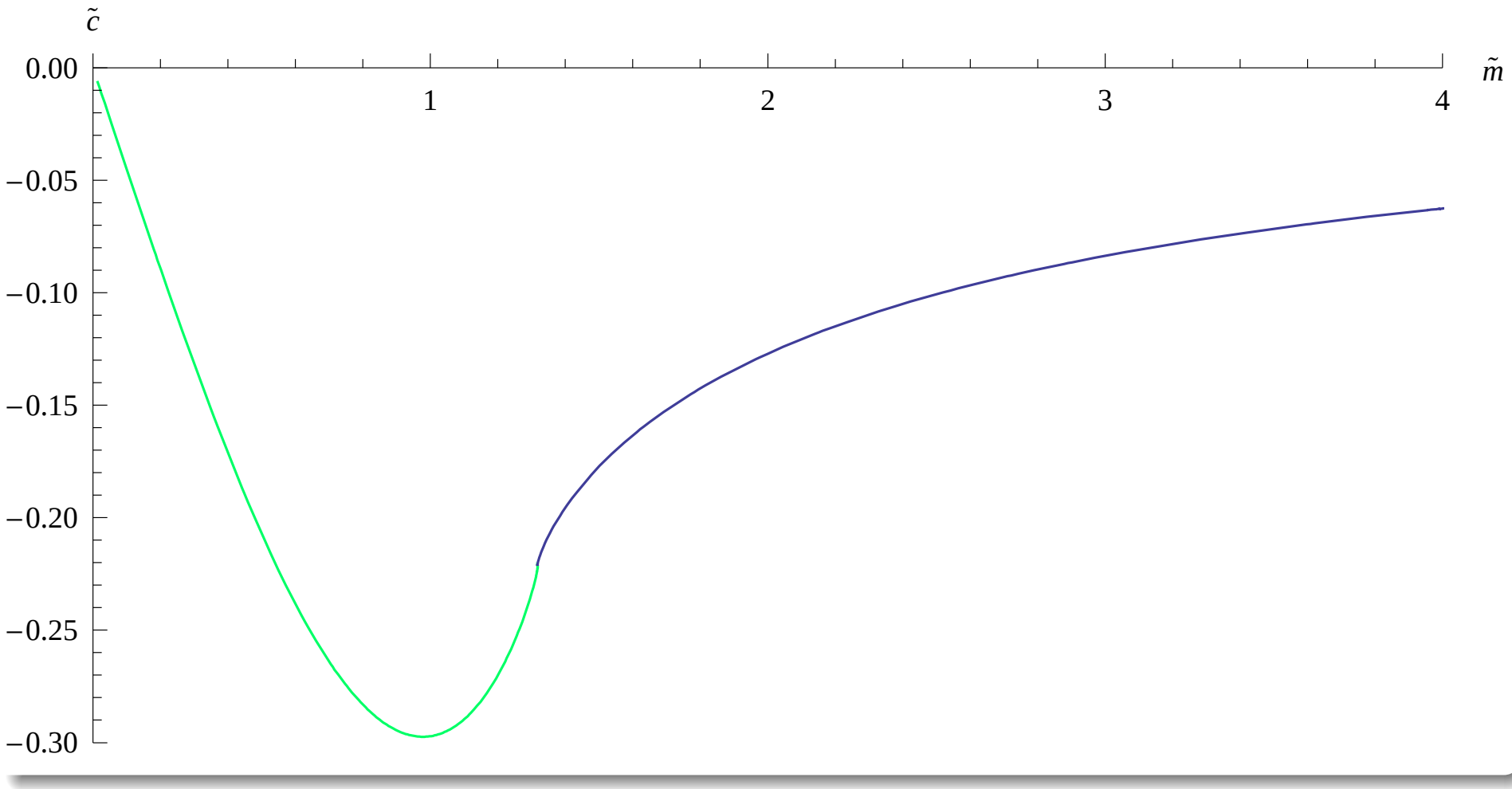
- Consistency of the brane embedding requires VEV for baryon current in x-direction

Electric Embeddings at $T = 0$: No CSB, Phase Transition

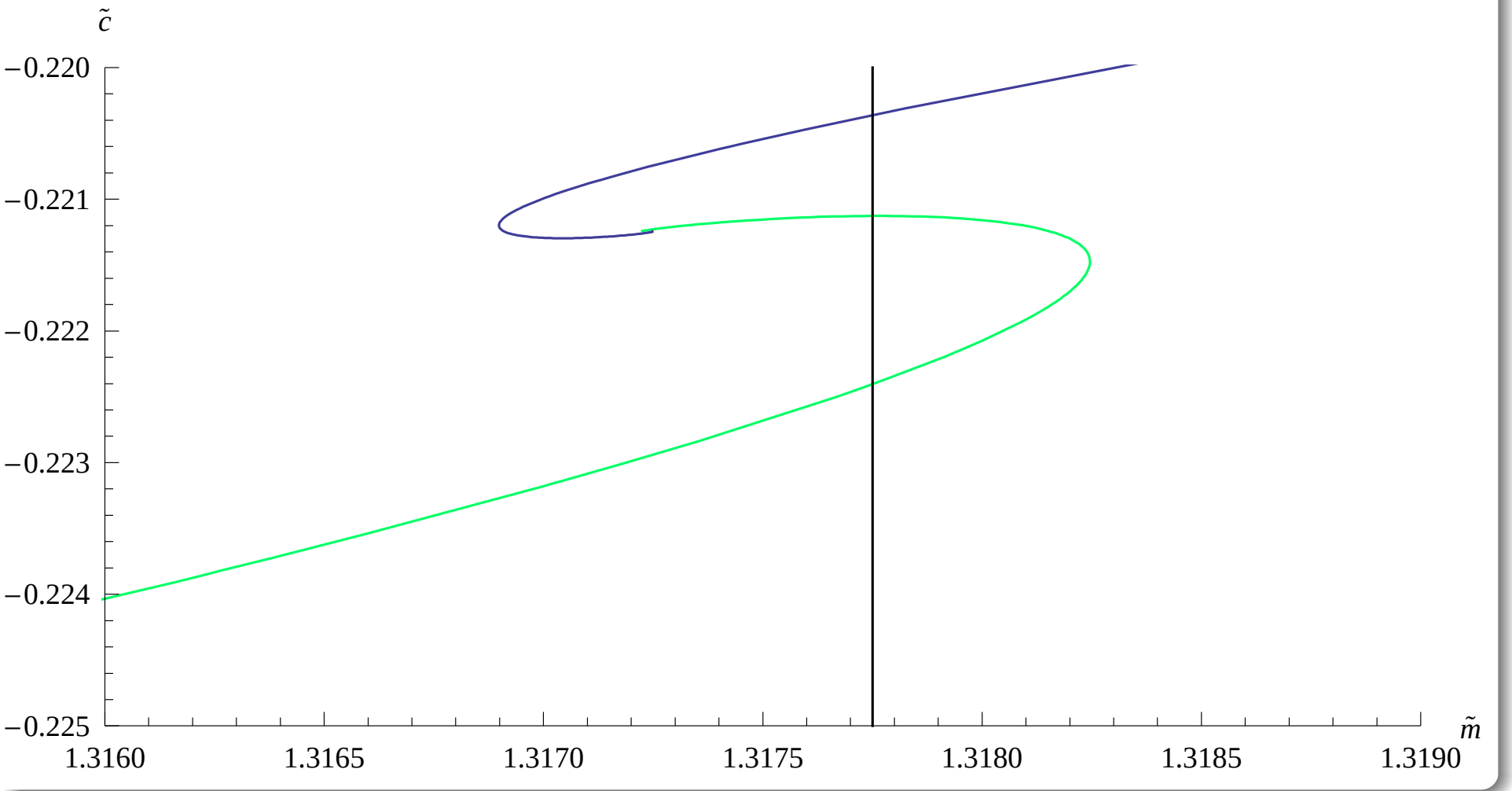


$\longrightarrow$ Dissociation of Mesons?

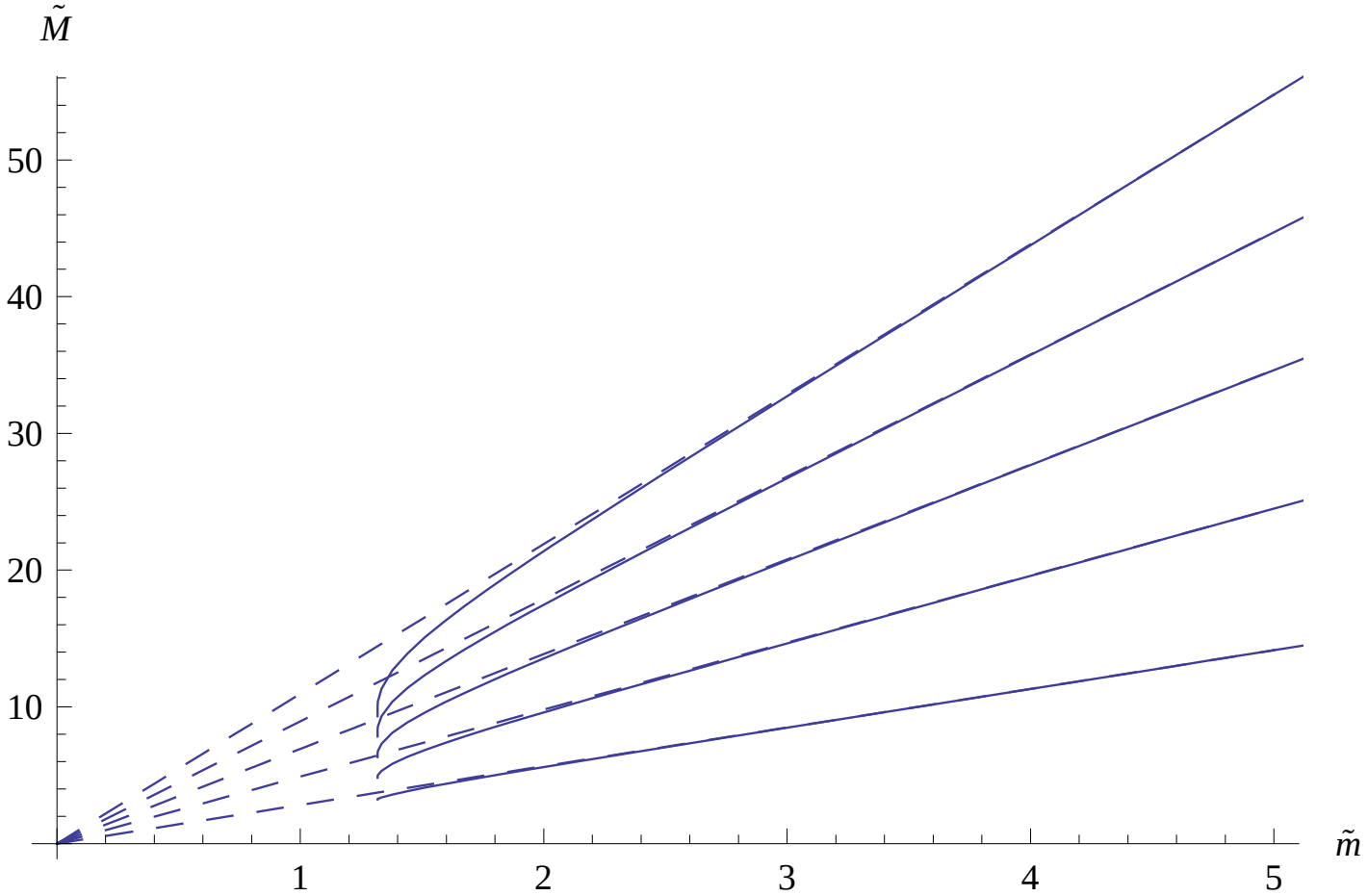
Condensate vs. Mass



Condensate vs. Mass: Phase Transition



Φ (I=0) Meson Spectrum at $T = 0$: $\Delta M < 0$



$\longrightarrow$ Dissociation of Mesons!

$\longrightarrow$ 2nd order Stark Effect: $\Delta M = -\frac{3}{4\sqrt{2}} \frac{B^2 R^2}{m^3}$

Conclusions and Outlook

Conclusions:

- Magnetic $T > 0$: B acts confining; Meson Melting phase transition, No molten phase and CSB above $\tilde{B}_{crit} \approx 16$; Φ-Spectrum: ΔM>0, Goldstone boson & GMOR
- Electric $T = 0$: Finite baryon number current, B acts deconfining by dissociation, no CSB, Stark shift $\Delta M \propto B^2$
- Electric $T > 0$: Embeddings $\rightarrow$ Outlook:

- Stability analysis of electric $T > 0$ embeddings
- Effect of baryon number current
- Phase diagram for the electric case
- Mesons at finite T & electric field
- Insights from nonperturbative QFT?