

Round table discussion: Critical Phenomena – lattice QCD & FRG

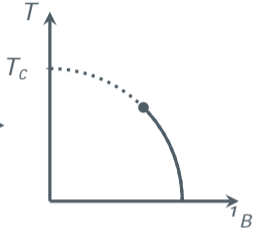
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CRC retreat in Halberstadt, 20.03.2024



Introduction

$$\mathcal{L} = \bar{\psi}(i\not{D} - m)\psi - \frac{1}{4}G_{\mu\nu}^a G^{\mu\nu a}$$



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Introduction



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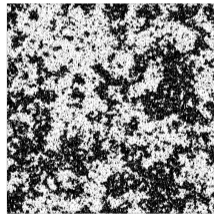
A key aspect: system becomes *critical* near a second order phase transition

→ universality, scale invariance

Scaling hypotheses & universality

Criticality: near a second order phase transition, the correlation length \gg diverges:

fluctuations on all length scales \rightarrow scale invariance



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exhibit the same behavior characterized by *critical exponents*,
scaling functions, ...

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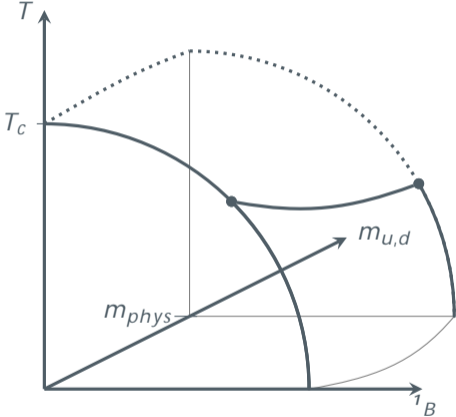
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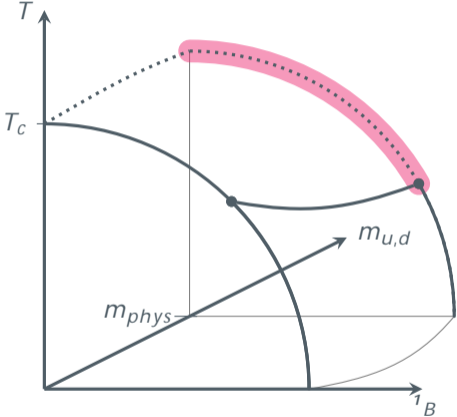
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... however, not every interesting aspect is universal,
e.g., location of the critical end point

QCD phase diagram & critical behavior

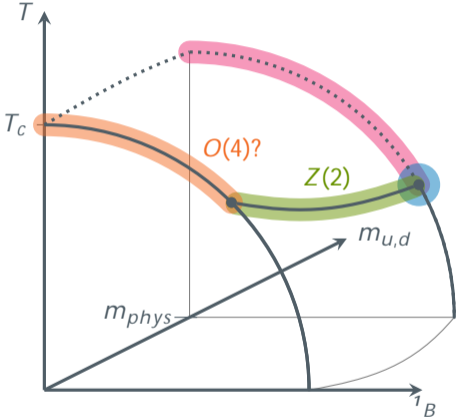


QCD phase diagram & critical behavior



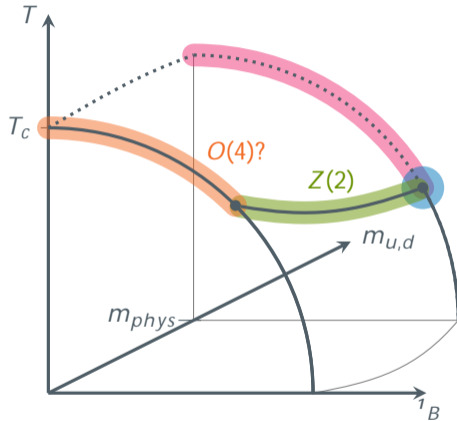
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QCD phase diagram & critical behavior



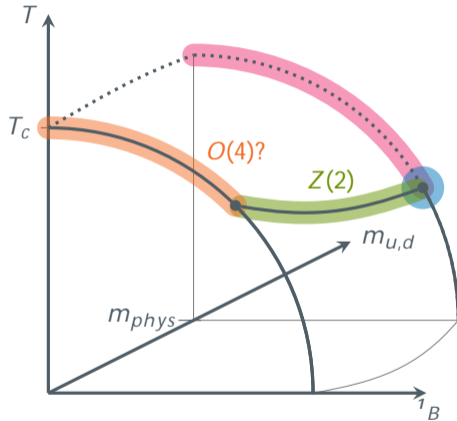
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QCD phase diagram & critical behavior

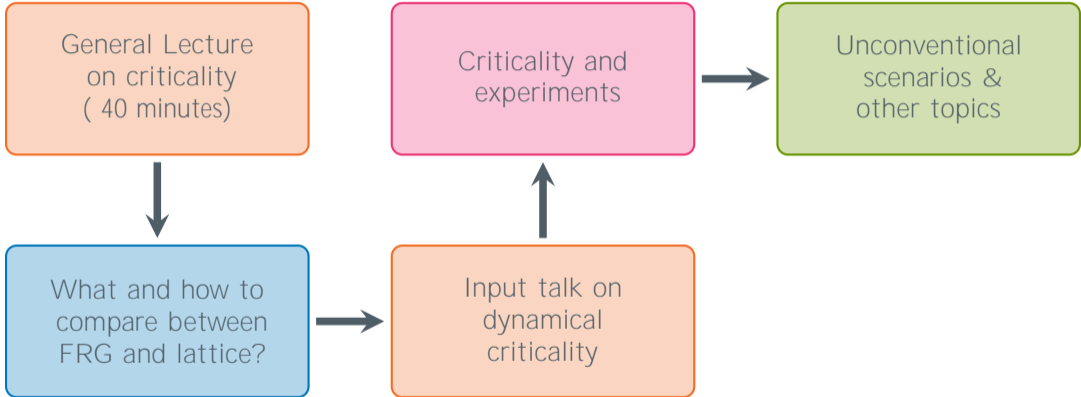


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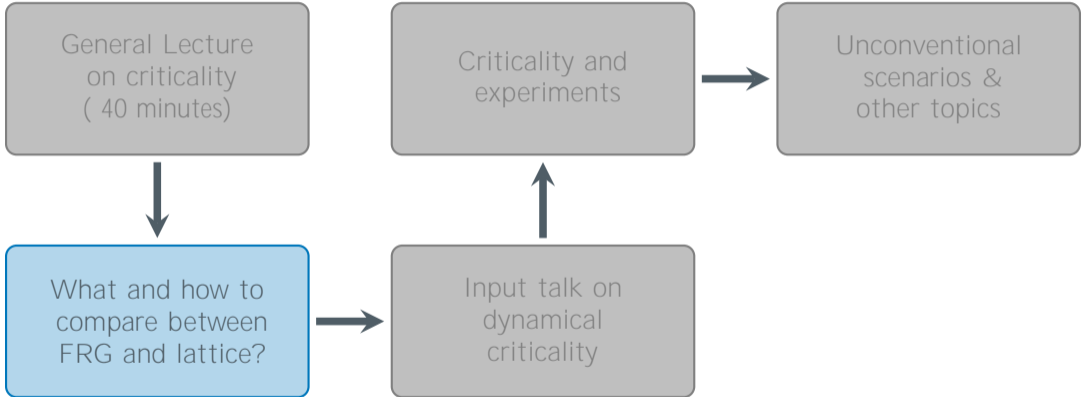
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... but how can we study them? And how does it compare to the *real world*, i.e., experiments?

Discussion plan



Discussion plan



Discussion plan – What and how to compare between FRG and Lattice?

Questions and topics that we want to discuss:

Precision determination of critical exponents and **identifying universality** classes from the lattice field theory and FRG

How can we determine **scaling windows** and do they differ between lattice field theory and FRG?

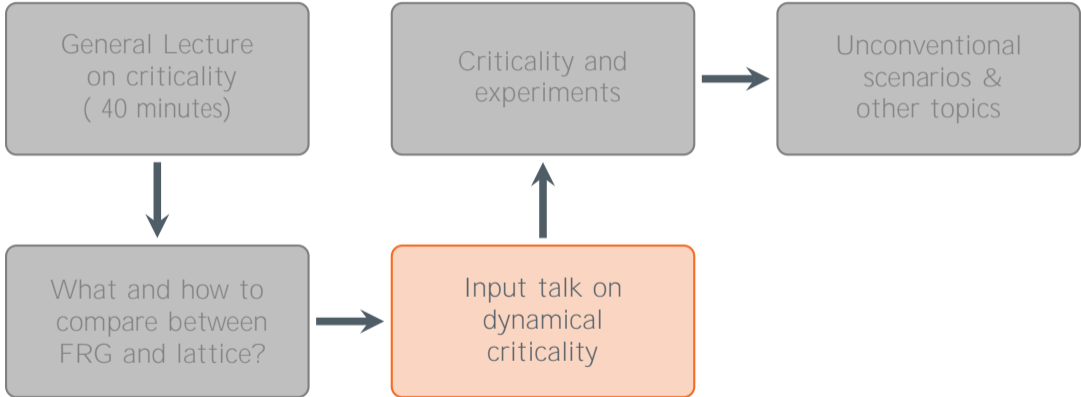
How to determine subleading effects to **scaling functions**?

Position of the **critical endpoint**? Which methods can we employ?

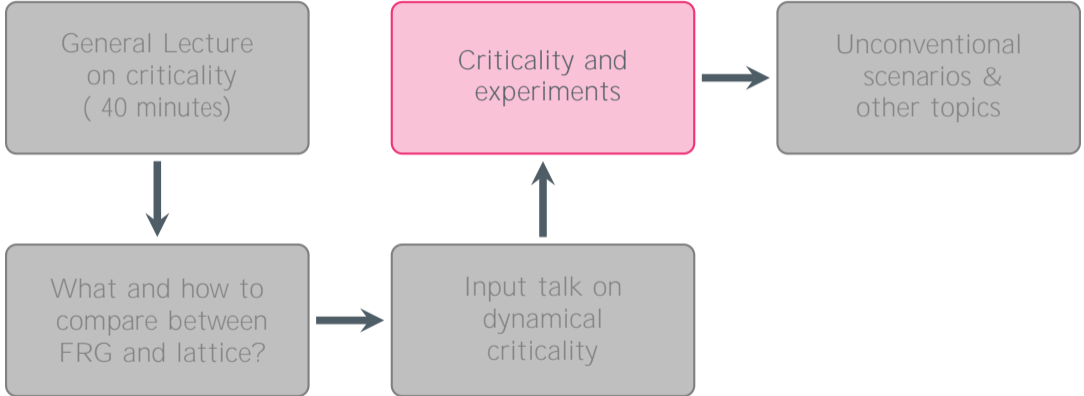
In particular: **Yang-Lee edge singularities** and what do we need for accurate identification and extrapolation?

Effective potentials from lattice and FRG: A better comparison?

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Discussion plan – Experimental situation

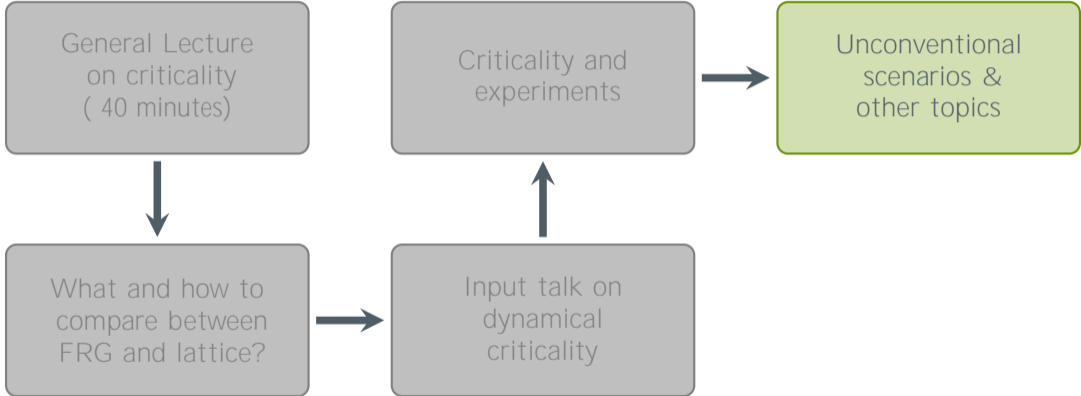
Questions that we want to discuss:

Where and what to look for to locate the critical endpoint in experiments?

How to deal with the dynamical nature of HICs? Which impact has **dynamical scaling**?
(L. v. Smekal's lecture)

Are the prediction of the critical endpoint compatible with neutron star mergers? Does the system even reach this point?

Discussion plan



Discussion plan – Unconventional scenarios

Questions that we want to discuss:

What if there is no true critical endpoint? What if it is a Lifshitz point?

Your input during the discussion!