

# QCD-like theories in strong magnetic fields

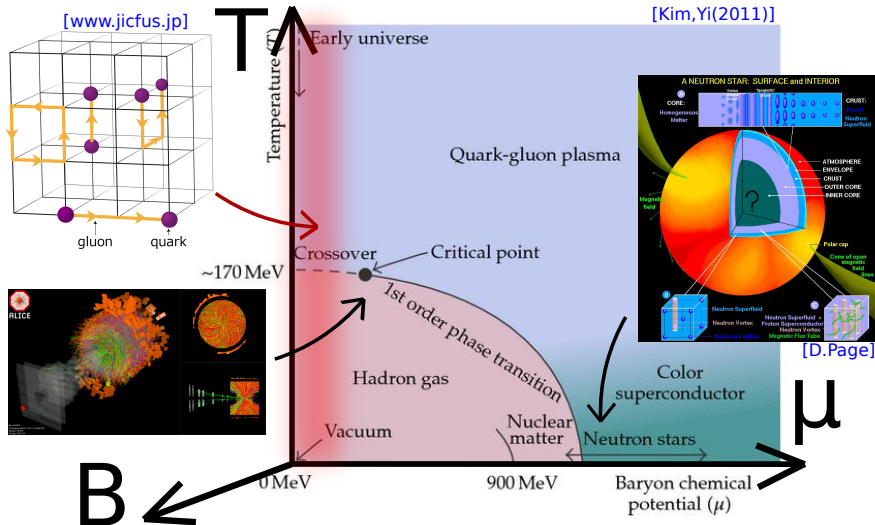
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Joint work with Tomáš Brauner and Georgios Filios

# Motivation: QCD phase diagram

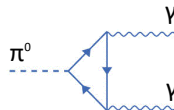
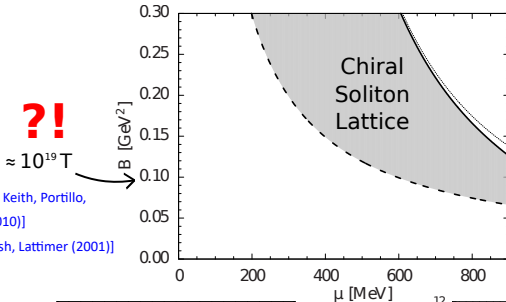


# Motivation: Chiral Soliton Lattice phase in QCD

[Son,Stephanov(2008)][Brauner,Yamamoto(2017)]

Ground state of QCD matter for sufficiently strong magnetic field and large enough baryon chemical potential: inhomogeneous condensate of neutral pions!

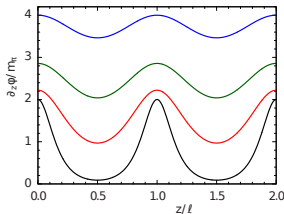
(Shown using chiral perturbation theory.)



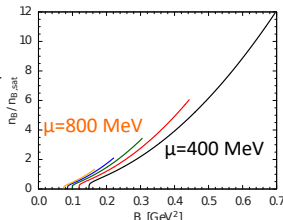
Neutral pions coupled to the magnetic field due to chiral anomaly!

[Ferrer, Incera, Keith, Portillo, Springsteen(2010)]  
[Cardall, Prakash, Lattimer (2001)]

spatially varied neutral pion field:



densities relevant for neutron stars:



# QCD-like theories in strong magnetic fields

[Tomáš Brauner, Georgios Filios, H.K.; Phys.Rev.Lett.123(2019), JHEP 1912 (2019) 029]

- In certain QCD-like theories (e.g., two-color QCD) the sign problem is absent  $\Rightarrow$  lattice simulations possible
- CSL-like phase present for sufficiently large magnetic fields! (Shown using chiral perturbation theory.)
- Conjecture of [Splittorff, Son, Stephanov (2001)] that the inhomogeneous phases exist only in theories with the sign problem disproved!

