

XXXII International (ONLINE) Workshop on High Energy Physics

ONLINE

Discussion session

QCD phase diagram under strong external magnetic field

lead by Igor Shovkovy



HOT PROBLEMS OF STRONG INTERACTIONS

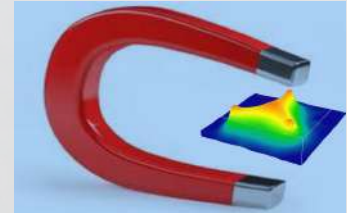
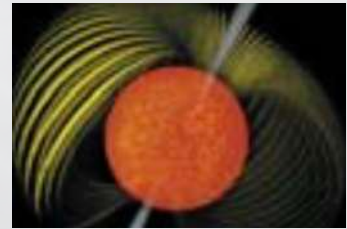
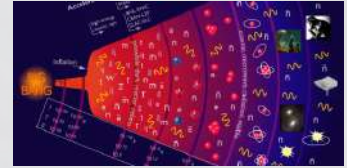
<https://indico.ihep.su/event/hepftXXXII>



MOTIVATION

QCD + magnetic field

- Early Universe with primordial magnetic fields
 10^{20} to 10^{24} Gauss ($\sqrt{|eB|} \sim 1$ GeV to 100 GeV)
- Relativistic collisions of heavy ions produce quark-gluon plasma & strong magnetic fields
 10^{18} to 10^{19} Gauss ($\sqrt{|eB|} \sim 100$ MeV)
- Magnetized QCD matter exist inside magnetars
 10^{14} - 10^{16} Gauss ($\sqrt{|eB|} \sim 1$ MeV to 10 MeV)
- Strong magnetic field is an instructive theoretical tool to study confined gauge theories such as QCD
 $\gtrsim 10^{19}$ Gauss ($\sqrt{|eB|} \sim 100$ MeV to 10 MeV)





DIRECTIONS OF RESEARCH

Current research directions

- Chiral symmetry (magnetic catalysis) in magnetized QCD (Hernandez, Farias, Markó)
- (De-)confinement in QCD with a magnetic field (D'Elia)
- Properties of mesons and baryons in strong magnetic fields (Farias, Markó)
- Thermodynamic properties of magnetized QCD matter (Endrődi)
- Transport properties of magnetized QCD matter
- Particle/photon emission (absorption) in magnetized QCD matter
- New phases of QCD matter induced by strong magnetic field (Ferrer)
- Collective modes in magnetized QCD matter/vacuum
- Anomalous properties of magnetized QCD matter
- Magnetic fields in heavy-ion collisions



PHYSICS QUESTIONS

Physics questions

- How does a magnetic field affect the properties of magnetars?
- Is the magnetic field sufficiently strong and long-lived to affect heavy-ion collisions?
- Can we infer the magnetic field in heavy-ion collisions from observables?
- How to test anomalous properties triggered by the magnetic field?
- What is the role of magnetic field in stellar mergers?
- Are there promising anomaly/plasma instability mechanisms of spontaneous generation of magnetic field in stars or early Universe?
- Any novel effects triggered by magnetic fields?



DISCUSSION

Topics of discussion

- Model calculations of QCD in a magnetic field:
 - To what degree various models of QCD in magnetic field are reliable?
 - How to improve effective models of QCD?
 - How to supplement model studies of QCD with other methods?
 - Are there any new predictions or insights from effective models?
- Magnetic field in lattice QCD calculations:
 - What is the underlying physics of the inverse magnetic catalysis?
 - How to disentangle chiral symmetry physics from (de-)confinement?
 - Anomalous physics in lattice simulations?
- Other theoretical and experimental tools in studies of magnetized QCD?