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Editorial

Topical issue on the QCD phase diagram in strong magnetic fields

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In recent years, the impact of strong magnetic fields on the strongly interacting matter phase diagram has been a very active field of research with important developments.

The presence of these strong magnetic fields modifies the dynamics of quarks, gluons and hadrons and is expected to have an enormous influence over all regions of the phase diagram: from the first stages of the Universe to the physics of neutron stars and the quark gluon plasma. As for the phase diagram in itself, one expects an impact on the chiral transition (and the respective Critical End Point location) as well as on the deconfinement transition.

From the theoretical point of view, ab-initio theory (lattice QCD calculations) together with the use of phenomenological models of QCD (including mean-field as well as beyond mean-field approximations such as the functional renormalization group and Dyson-Schwinger equations or holographic QCD models) have been improving our understanding of how matter behaves under extreme conditions at non-zero temperature and/or density in the presence of such external magnetic fields. An important achievement was the investigation of inverse magnetic catalysis, which has been established by lattice QCD calculations and may rule out too simplistic mean field models of the QCD phase diagram. More evolved models, however, continue to play a very relevant role in our understanding of effects from strong magnetic fields on compact star structure (magnetars) and on heavy ion collision phenomenology (including the chiral magnetic effect) that may help to uncover the response of the QCD phase diagram to strong magnetic fields.

The topical issue at hand provides a number of review articles for relevant topics in this field as well as research articles representing current progress, which we hope will be useful for the field.

Pedro Costa, Débora Peres Menezes, Vladimir Skokov and Carsten Urbach

Guest Editors

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References

1. J.D. Brandenburg, W. Zha, Z. Xu, Eur. Phys. J. A **57**, 299 (2021). arXiv:2103.16623 [hep-ph]
2. G. Cao, Eur. Phys. J. A **57**, 264 (2021). arXiv:2103.00456 [hep-ph]
3. D. Chatterjee, J. Novak, M. Oertel, Eur. Phys. J. A **57**, 249 (2021). arXiv:2108.13733 [nucl-th]
4. U. Gursoy, Eur. Phys. J. A **57**, 247 (2021). arXiv:2104.02839 [hep-th]
5. A. Ayala, L.A. Hernández, M. Loewe, C. Villavicencio, Eur. Phys. J. A **57**, 234 (2021). arXiv:2104.05854 [hep-ph]
6. S. Iwasaki, M. Oka, K. Suzuki, Eur. Phys. J. A **57**, 222 (2021). arXiv:2104.13990 [hep-ph]
7. A. Yamamoto, Eur. Phys. J. A **57**, 211 (2021). arXiv:2103.00237 [hep-lat]
8. J.O. Andersen, Eur. Phys. J. A **57**, 189 (2021). arXiv:2102.13165 [hep-ph]
9. T. Kojo, Eur. Phys. J. A **57**, 317 (2021). arXiv:2104.00376 [hep-ph]
10. P.V. Buividovich, D. Smith, L. von Smekal, Eur. Phys. J. A **57**, 293 (2021). arXiv:2104.10012 [hep-lat]
11. W.R. Tavares et al., Eur. Phys. J. A **57**, 278 (2021). arXiv:2104.11117 [hep-ph]
12. M. Ferreira, A. Rabhi, C. Providência, Eur. Phys. J. A **57**, 263 (2021). arXiv:2106.03590 [nucl-th]

13. G. Giacalone, C. Shen, Eur. Phys. J. A **57**, 230 (2021). arXiv:2104.01890 [nucl-th]
14. B.C.T. Backes, K.D. Marquezb, D.P. Menezes, Eur. Phys. J. A **57**, 229 (2021). arXiv:2103.14733 [nucl-th]
15. F. Anzuini, A. Melatos, Eur. Phys. J. A **57**, 220 (2021). arXiv:2106.04744 [hep-ph]
16. V. Dexheimer, K.D. Marquez, D.P. Menezes, Eur. Phys. J. A **57**, 216 (2021). arXiv:2103.09855 [nucl-th]
17. H.T. Ding, S.T. Li, Q. Shi, X.D. Wang, Eur. Phys. J. A **57**, 202 (2021). arXiv:2104.06843 [hep-lat]
18. A.N. Tawfik, A.M. Diab, Eur. Phys. J. A **57**, 200 (2021). arXiv:2106.04576 [hep-ph]
19. H. Pais, B. Bertolino, J. Fang, X. Wang, C. Providência, Eur. Phys. J. A **57**, 193 (2021). arXiv:2106.00347 [nucl-th]
20. R.M. Aguirre, Eur. Phys. J. A **57**, 166 (2021)
21. D. Dudal, A. Hajilou, S. Mahapatra, Eur. Phys. J. A **57**, 142 (2021). arXiv:2103.01185 [hep-th]
22. S.A. Ferraris, D.G. Dumm, A.G. Grunfeld, N.N. Scoccola, Eur. Phys. J. A **57**, 141 (2021). arXiv:2103.00982 [hep-ph]
23. J. Moreira, P. Costa, T.E. Restrepo, Eur. Phys. J. A **57**, 123 (2021). arXiv:2101.12004 [hep-ph]
24. N. Chaudhuri, S. Ghosh, S. Sarkar, P. Roy, Eur. Phys. J. A **56**, 213 (2020). arXiv:2003.05692 [nucl-th]
25. P.M. Lo, M. Szymański, K. Redlich, C. Sasaki, Eur. Phys. J. A **58**, 172 (2022). arXiv:2109.04439 [hep-ph]