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Theory of the CBM experiment: QCD phase transitions, critical phenomena and rare diagnostic probes

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In the Compressed Baryonic Matter (CBM) experiment at FAIR strongly interacting matter at highest baryonic densities will be produced, which offers unprecedented opportunities for the investigation of this yet unexplored region of the QCD phase diagram.
It will fill the gap in understanding bulk properties like the equation of state between the quark-gluon plasma at vanishing baryonic density and high temperatures as it existed in the early universe and is produced at top-RHIC and LHC energies and the cold but ultradense matter in the core of neutron stars.
At high baryochemical potential various effective models predict a first-order phase transition between chirally-restored, deconfined and chirally-broken, confined matter. As a consequence there must be a critical point in the plane of temperature and baryochemical potential. In order to relate observables in heavy-ion collisions to thermodynamical features at the phase transition and the critical point dynamical modeling of the fluctuations is necessary.
The symmetries of QCD, which are relevant at the phase transition, also determine properties of in-medium excitations and can be studied by electromagnetic probes, which penetrate the matter without interaction.
Open charm is an ideal probe of transport properties of the medium as it is expected not to fully thermalize within. The properties of the interaction between heavy quarks and their dissociation and regeneration dynamics are investigated by the charmonia spectra and their suppression. It will give useful insight into the nature of the produced medium and the onset of deconfinement.
This talk will discuss the theoretical challenges that come along with the physics program at CBM.

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