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Density Functionals and EoS for heavy-ion collisions, neutron stars, mergers and supernovae

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We present a novel relativistic density functional approach for QCD matter, which can be motivated by a nonlocal medium-screened confining interaction among quarks. The approach suggests a phenomenological confining mechanism equivalent to suppressing excitations of quark quasiparticles by their large self-energies already at the mean-field level. Chirally symmetric form of the functional provides spontaneous breaking and dynamical restoration of chiral symmetry of QCD and allows representing the approach as a chiral quark model with self-consistently derived medium-dependent couplings. Hadrons are systematically introduced to the approach as color-singlet (anti)quark correlations with the corresponding quantum numbers. The approach explains the chemical freeze-out of the fireball created in relativistic collisions of heavy ions (HIC) via the Mott dissociation of hadrons. Supplemented with the repulsive vector-isoscalar, vector-isovector and attractive diquark pairing interactions, the density functional is applied for modeling neutron stars (NS) and constructing equation of state for supernova explosions and mergers of NS. It is shown that color superconductivity drives trajectories of evolution of the QCD matter in these dynamical processes toward the high temperatures typical for HIC.

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