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Early quark deconfinement in compact star astrophysics and heavy-ion collisions

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We outline the role that an early deconfinement phase transition from normal nuclear matter to a color superconducting quark-gluon plasma phase plays for the phenomenology of supernova explosions and binary neutron star mergers. To this end we extend the compact star equation of state (EoS) from vanishing to moderately high temperatures that become accessible in the CBM experiment at FAIR. We study the connection of such hybrid EoS with the mass-radius relation of cold compact stars, including the intriguing possibility of additional families, as a consequence of the presence of an early and strong phase transition. Special emphasis is devoted to the simultaneous fulfillment of the new NICER mass and radius constraint from PSR J0740+6620 and the tidal deformability constraint from GW170817 which require the EoS to be soft at about twice saturation density and then to stiffen. Such a pattern is provided by an early and strong deconfinement transition. Dynamical scenarios are being considered, such as binary compact star mergers including the subsequent emission of gravitational waves and supernova explosions of massive supergiant stars where neutrinos play the role of messengers.

Authors: BAUSWEIN, Andreas; BLASCHKE, David; IVANYTSKYI, Oleksii (University of Wroclaw); FISCHER, Tobias (Institute of Theoretical Physics, University of Wroclaw)

Presenter: IVANYTSKYI, Oleksii (University of Wroclaw)

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