

QUARK–NUCLEAR HYBRID EoS WITH EXCLUDED-VOLUME EFFECTS*

M.A.R. KALTENBORN

Department of Physics, The George Washington University
Washington DC, USA

D. BLASCHKE

Institute of Theoretical Physics, University of Wrocław, Wrocław, Poland
and
Bogoliubov Laboratory of Theoretical Physics, JINR, Dubna, Russia
and
National Research Nuclear University (MEPhI), Moscow, Russia

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We employ a new quark–nuclear matter hybrid equation of state that takes into account both quark Pauli blocking in hadronic matter and screening of interactions in quark matter as excluded-volume effects. We obtain mass-radius relations for hybrid stars that fulfill the $2M_{\odot}$ constraint while exhibiting the high-mass twin phenomenon.

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In the recent work [1], the question of whether a phase-transition from hadronic to deconfined quark matter occurs in the interior of compact stars has been considered within a new approach to the hybrid equation of state (EoS) within the two-phase description. For the hadronic phase, the well-known DD2 model, developed by Typel *et al.* [2], was implemented with the excluded volume modification at supersaturation densities. For the quark matter phase, the string-flip model (SFM) [3, 4] was revived, and the confining interactions between colored constituents were included by a density-dependent mean-field approximation. At low densities, the quark mass diverges, thus emulating confinement by the exclusion of the quark degrees of freedom. As the density increases, the Pauli-blocking effects lead first to a

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strong repulsion and then to the delocalization of the quark wave function, driving the system into a homogeneous quark matter phase. As high-mass twins (HMT), we denote two compact stars that have the same mass (including the presently best known high mass of pulsar PSR J0348+0432 with $M = 2.01 \pm 0.04 M_\odot$ [5]), but very distinct radii. In order to support this phenomenon, the EoS of the compact star matter must have a strong first-order phase transition, while not violating causality, as seen in figure 1. The observation of HMTs would support a CEP in the QCD phase diagram.

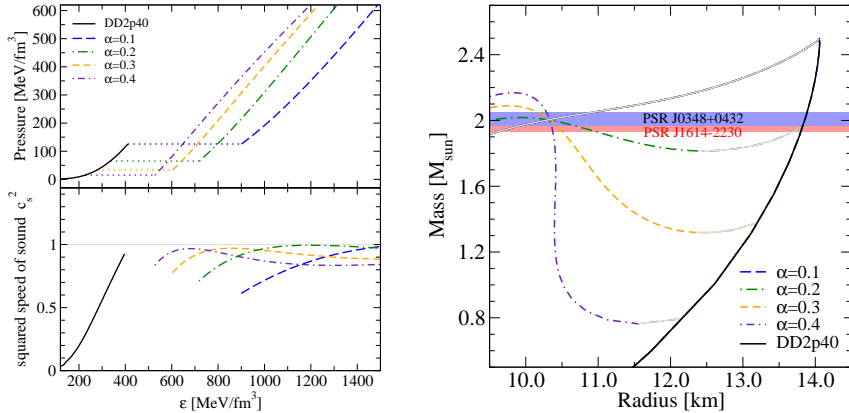


Fig. 1. (Left) Pressure *versus* energy density for different values of the available volume parameter α in the quark matter phase. The hadronic phase is shown with a transition to the quark phase corresponding to the Maxwell-construction. The lower panel shows the corresponding squared speed of sound that shall be limited from above by the causality constraint to the squared speed of light $c_s^2 < 1$. (Right) The M - R relations corresponding to the EoS curves in the left panel. The solid gray lines represent the unstable configurations of hybrid stars.

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