# Mapping of Dirac–Hartree–Fock Approach onto the Relativistic Mean Field Model

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In the present work, we have mapped the exchange Fock contributions from the Dirac–Hartree–Fock (DHF) approach for nuclear matter onto the direct Hartree terms. This results in the relativistic mean field (RMF) model with the density dependent couplings. The density dependence of the effective coupling constants thus reflects the exchange correlations. The exchange part of an energy density of the linear DHF model in dense matter is evaluated in a parameter-free closed form and, after the rearrangement of the terms, expressed as density functional.

It is shown that the exchange contributions are responsible for an increase of the RMF coupling strengths in comparison with the DHF ones. The density dependence of the mapped Fock terms is, however, rather small, and does not account for the one seen in Dirac–Brueckner–Hartree–Fock (DBHF) calculations or phenomenological analyses.

Therefore, the developed formalism has been extended to the nonlinear DHF approximation with field selfcouplings allowed. The nonlinear self–interactions give essential density dependence of effective couplings that is decoupled from the Fock one. For normal nuclear matter densities just the isoscalar field ($\sigma$– and $\omega$–meson exchange) selfinteractions are relevant. The density dependence in isovector field ($\rho$– and $\delta$–meson exchange) is induced through exchange interactions. For dense matter also the isovector field selfcouplings may be used to model the density dependence.

Thus, this contribution is a step in a direction to formulate the effective nuclear density functional suitable for description of wide class of nuclear phenomena over a broad range of densities including the exotic and superheavy nuclei, as well as the neutron stars.