3-Body Contributions to the Density Dependent NN-Interaction

A. Ataie and H. Lenske

Justus-Liebig-Universität Gießen
Institut für Theoretische Physik I

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JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

European Graduate School
Complex Systems of Hadrons and Nuclei
Copenhagen - Gießen - Helsinki - Jyväskylä - Torino

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Outline

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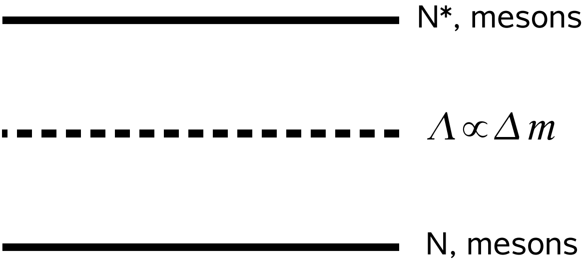
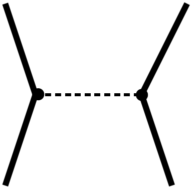
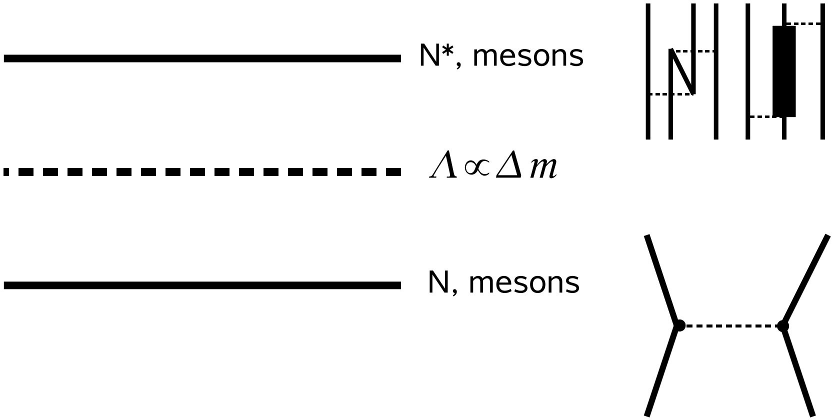
NN-Interaction

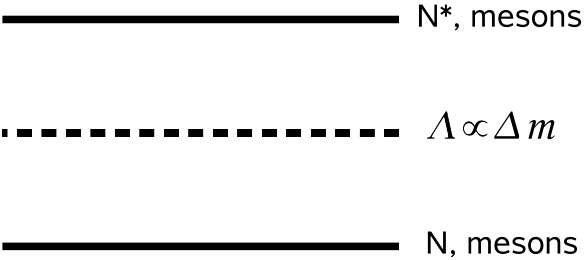


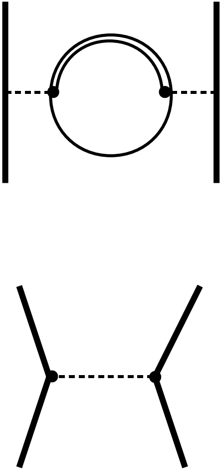


NN-Interaction



NN-Interaction





In-Medium Effects

in-medium effects

In-medium nucleons are embedded into a background of other nucleons with which they interact as well.

- Pauli principle
- three and more body effects

Two Body Scattering Amplitude

Bethe-Salpeter

$$K_2 = V_2 + V_2 G_2 Q_F K_2$$

with:

- V_2: two-body interaction
- G_2: NN propagator
- Q_F: Pauli-projector depending on the Fermi-momentum k_f

formal solution

$$K_2(q', q, \rho) = \frac{1}{1 - V_2 G_2 Q_F} \cdot V_2(q', q)$$

Scattering Amplitude for Full Interaction

full interaction

$$V(q', q, \rho) = V_2(q', q) + V_3(q', q, \rho)$$

with V_3: medium-modified interaction

modified Bethe-Salpeter equation

$$K = V_2 + V_3 + (V_2 G_2 Q_F + V_3 G_3 Q_F)K$$

formal solution for full amplitude

$$K = \frac{1}{1 - V_3 G_3 Q_F}(V_2 + V_2 G_2 Q_F)K + \underbrace{\frac{V_3}{1 - V_3 G_3 Q_F}}_{K3}$$

with:

- $\chi = \frac{1}{1 - V_3 G_3 Q_F}$: susceptibility tensor
- $K_2 = (V_2 + V_2 G_2 Q_F)K$: two body scattering amplitude

redefined scattering amplitude

$$K' = \chi K_2$$

Attaching the susceptibility as a vertex scaling factor to the 2-body Born term:

$$V_2' = \chi V_2$$

$$K' = V_2' + V_2' G_2 Q_F K_2$$

formal solution

$$K' = \frac{1}{1 - V_2' G_2 Q_F} \cdot V_2'$$

Ansatz for 2-body interaction:

$$V_2' = \sum_m \chi_m(\rho) V_m(p^2)$$

Density Dependent Rescaling

density dependent rescaling

$$\begin{aligned} K' &= V_2' + V_2' G_2 Q_F K_2 \\ &= \sum_m z_m(\rho) V_m(\vec{k}_1, \vec{k}_2) \end{aligned}$$

with:

$$V_m = \frac{4\pi g^2}{m^2} \cdot \frac{m^2}{m^2 + p^2} F_m(p)$$

The additional susceptibility tensor χ acting as a density dependent rescaling of the meson-nucleon vertices.

EoS for Infinite Nuclear Matter

ground state energy

$$E = \frac{3}{5}\tau\rho + \frac{1}{2}\rho E_{int}$$

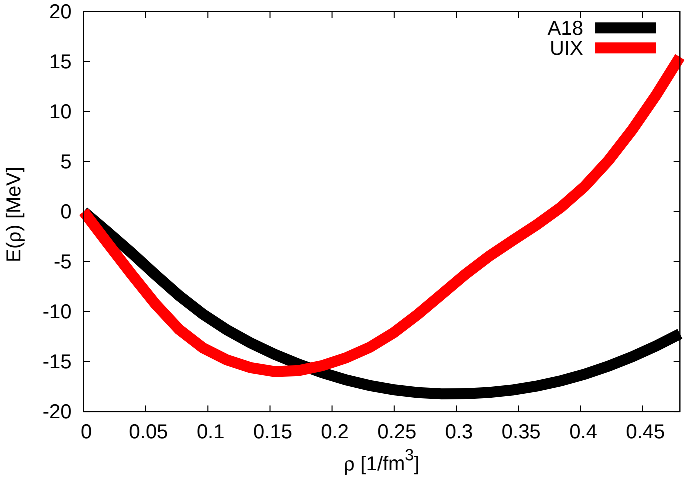
Ansatz for the interaction energy

$$E_{int} = \sum_m z_m(\rho) E_m(k_F)$$

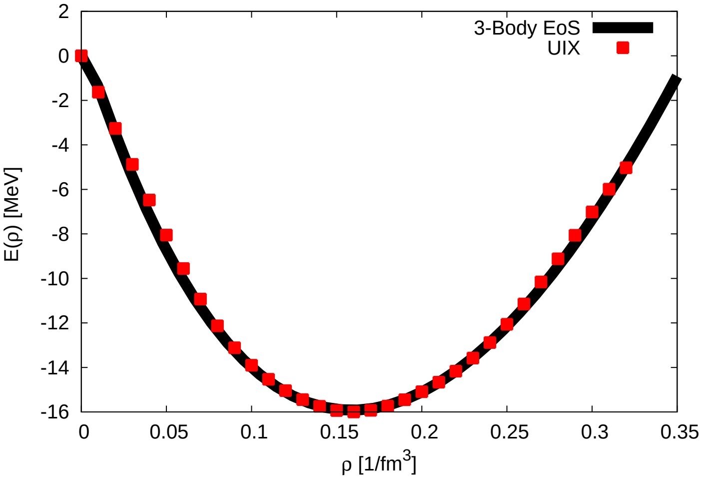
with:

$$E_m = N_s N_q \int \frac{d^3k_1}{(2\pi)^3} \int \frac{d^3k_2}{(2\pi)^3} \Theta(k_F^2 - k_1^2)\Theta(k_F^2 - k_2^2) \left(V_m^{(D)}(0) + V_m^{(E)}(\vec{k}_1 + \vec{k}_2)\right)$$

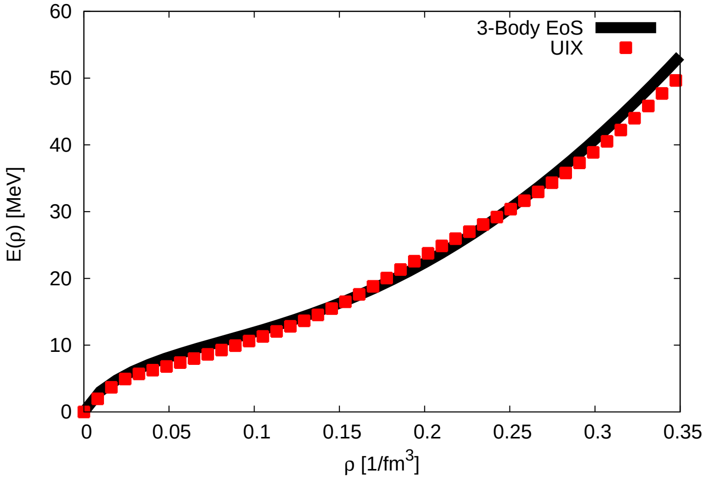
EoS for 2 and 3-Body Interaction



EoS for Symmetric Nuclear Matter



EoS for Pure-Neutron Matter



Summary and Outlook

Summary

- Coming from free NN-Scattering one has to consider in-medium effects
- Three body effects can be described by a density dependent rescaling of the vertices
- Our Ansatz coincides the UIX-interaction for symmetric nuclear and pure-neutron matter

Outlook

- Description of hyper nuclear matter
- Application in nuclear structure calculations