Low density nuclear matter in effective field theory

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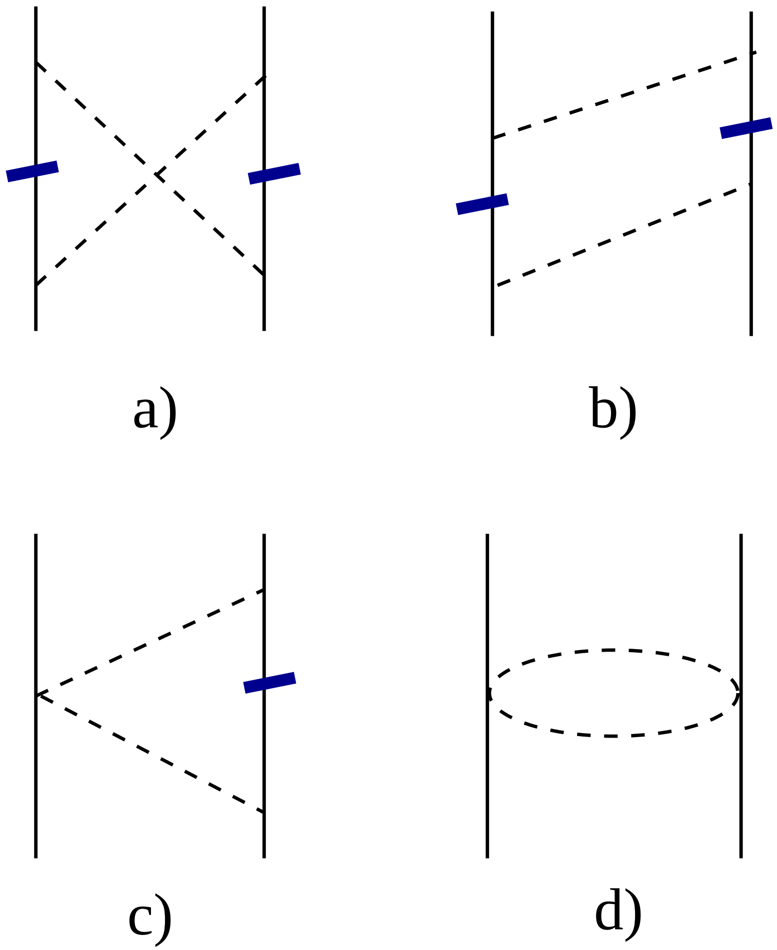
Motivation

E. Epelbaum, Prog. Part. Nucl. Physics 57(2006)654



Nuclear matter NLO

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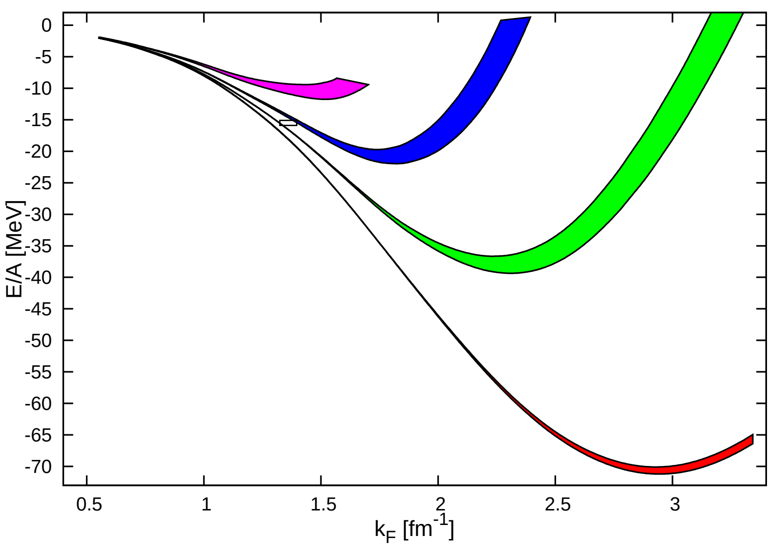

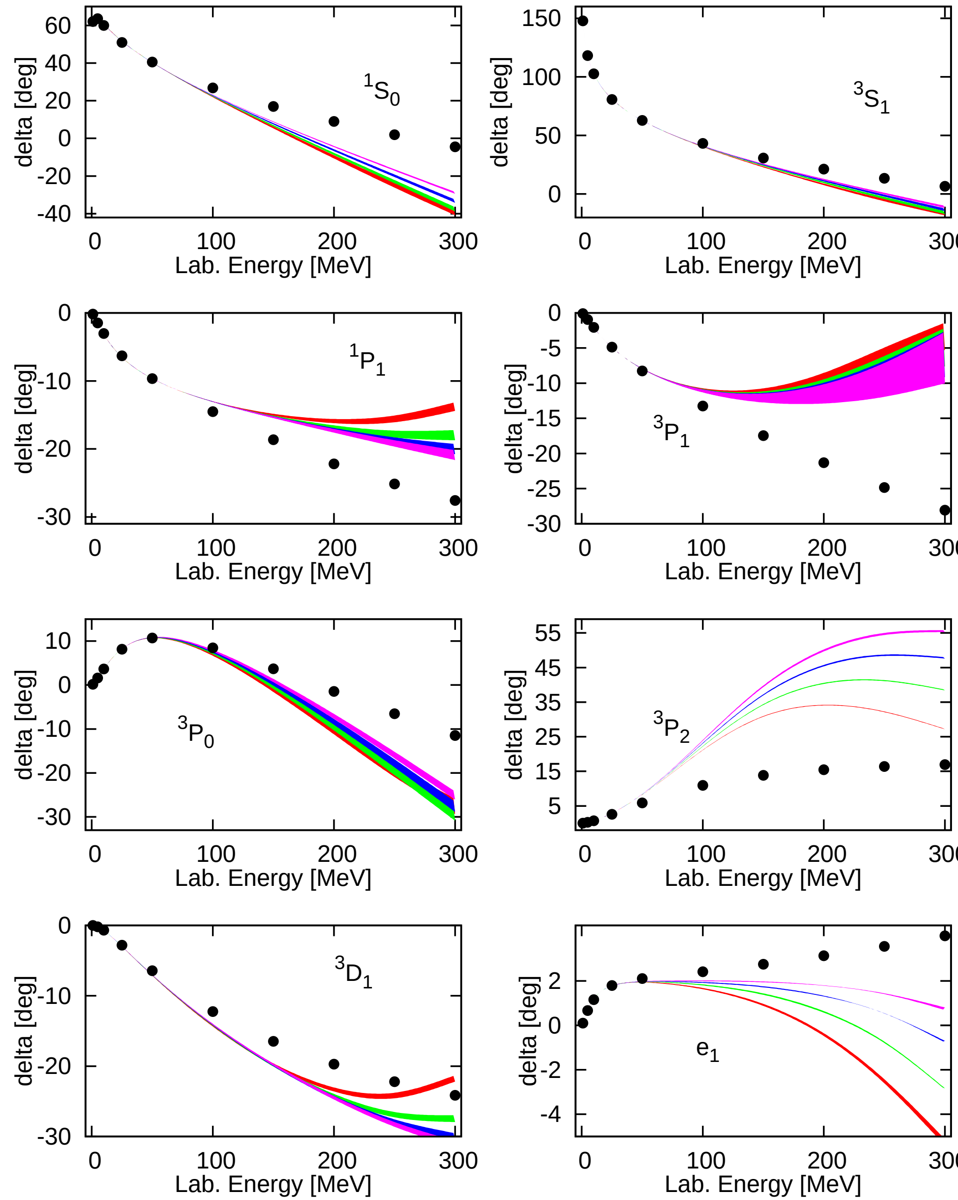

Nuclear matter NNLO(two-body)

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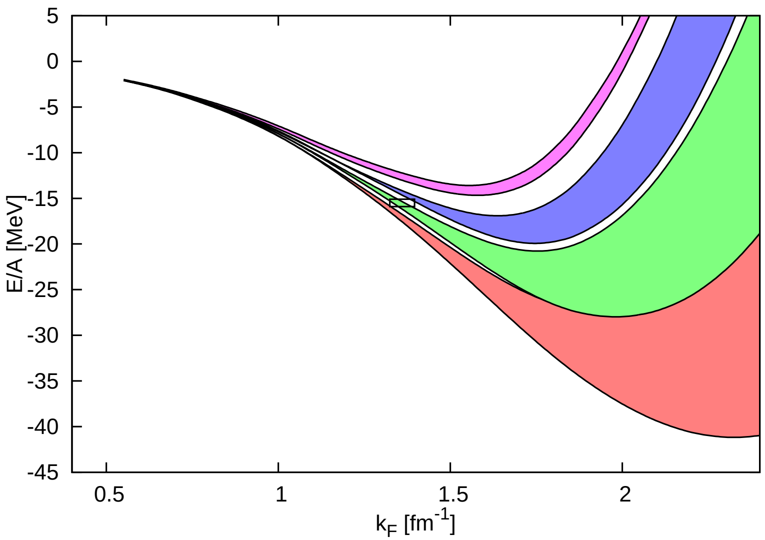

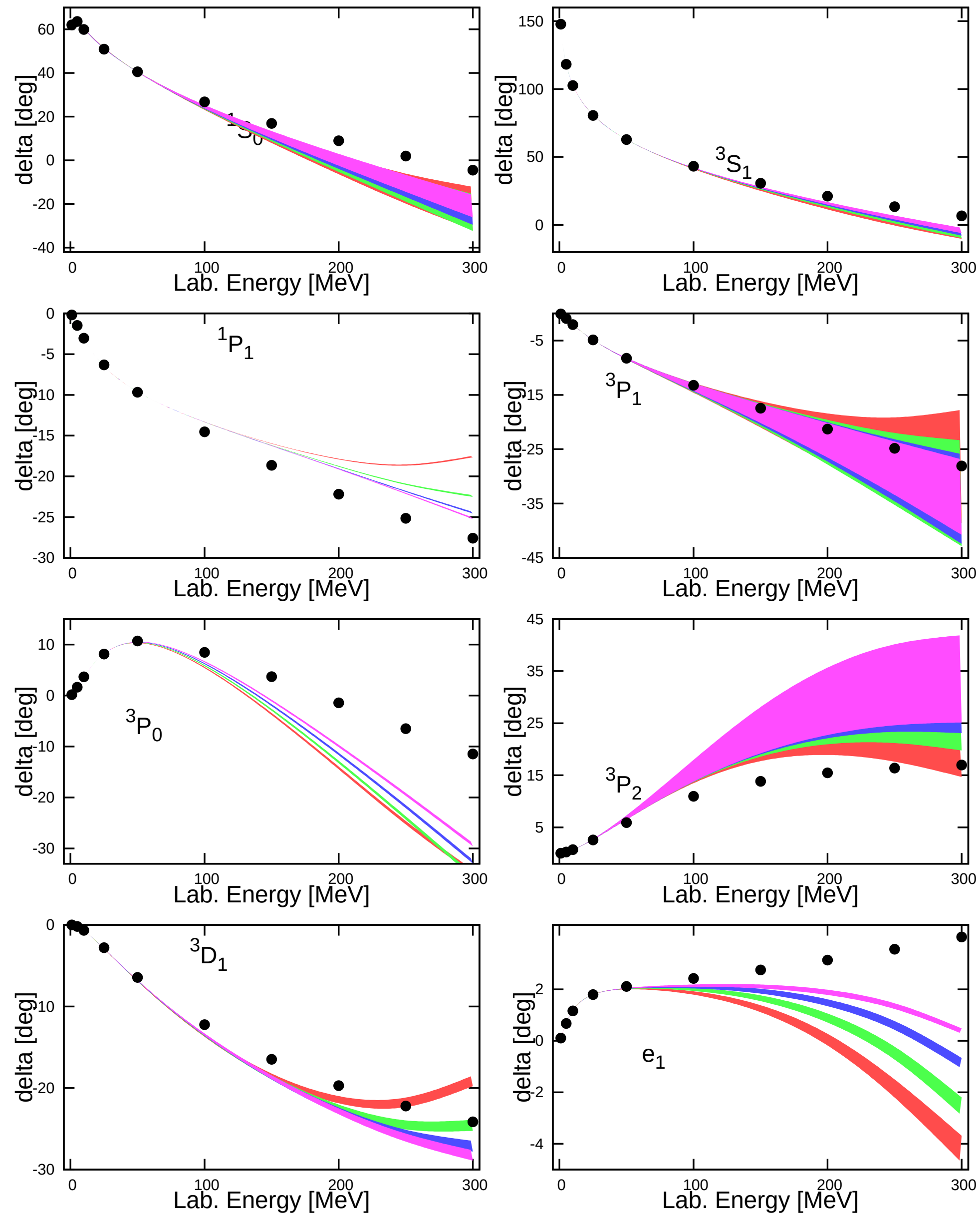

Nuclear matter NNLO(326)

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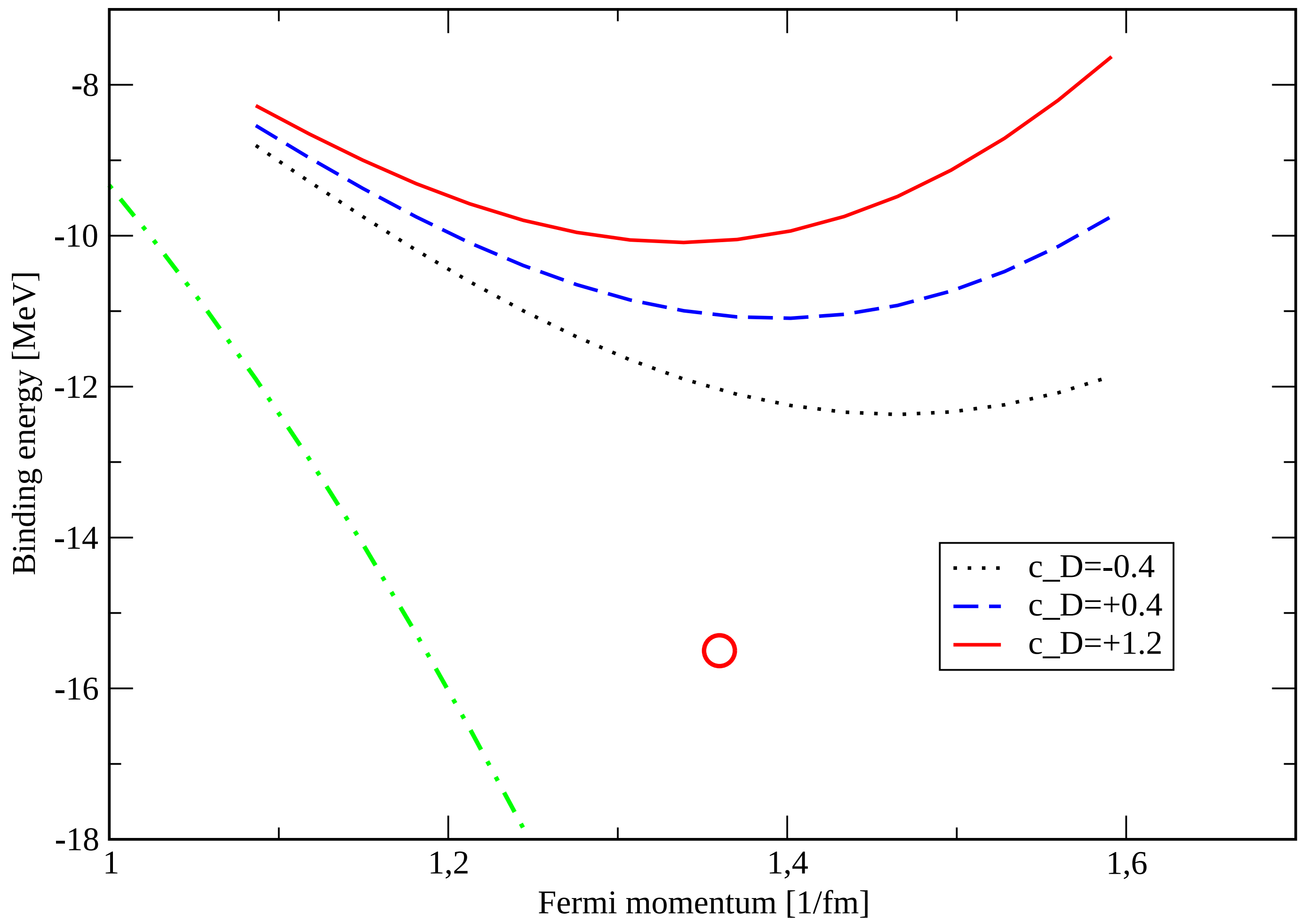
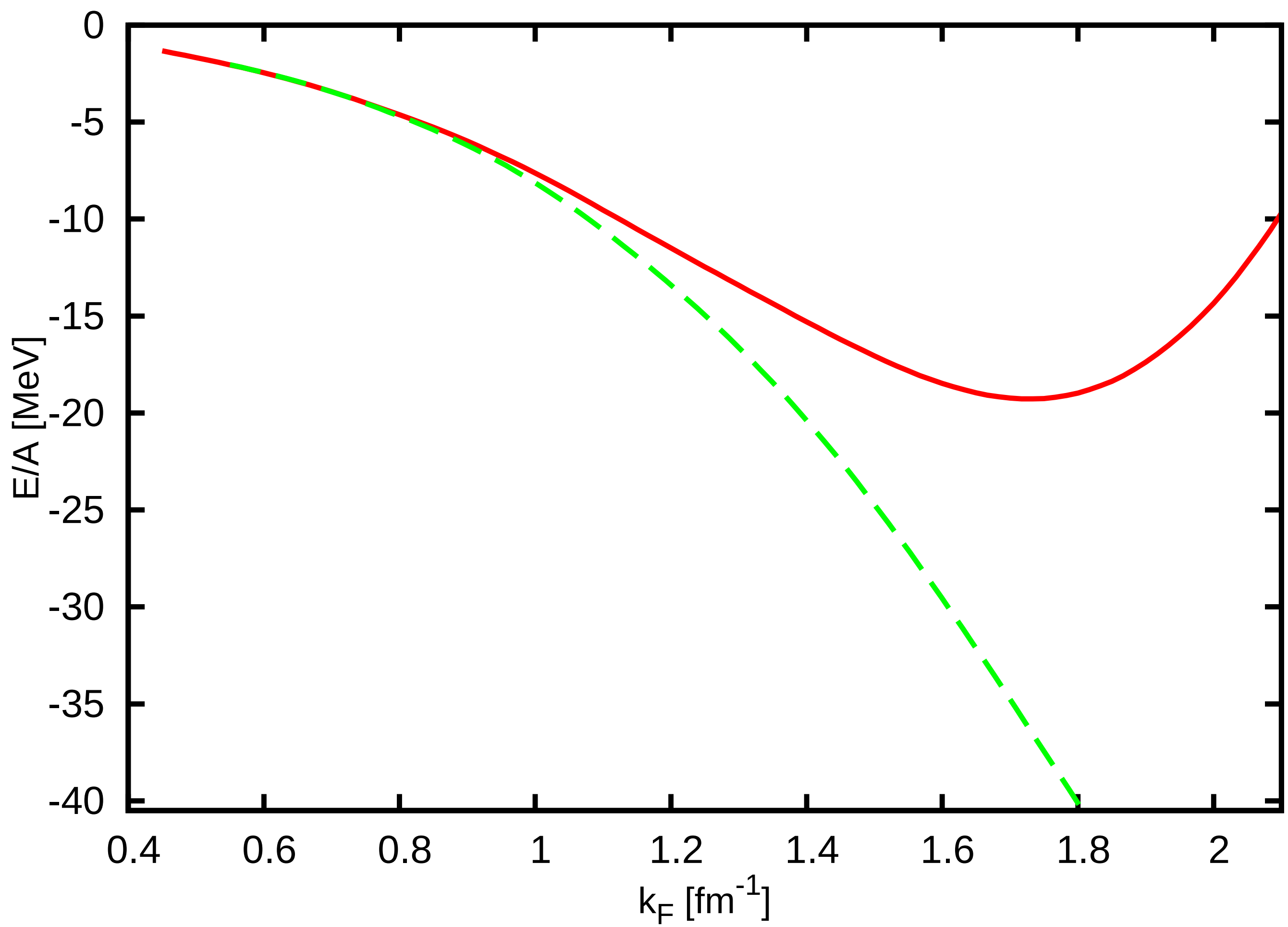
$\Lambda = 326$ MeV



Nuclear matter NNLO(550)

$\Lambda = 550$ MeV

c_D, c_E: A. Nogga



Numerical experiment A=0.025

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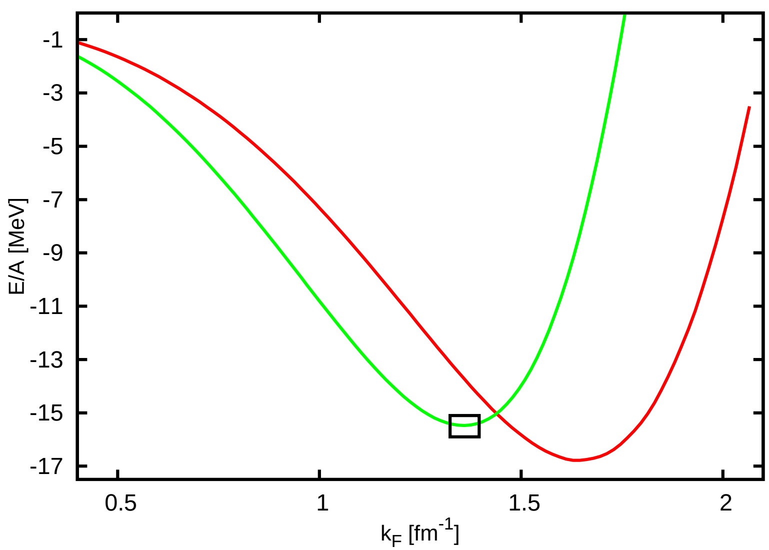
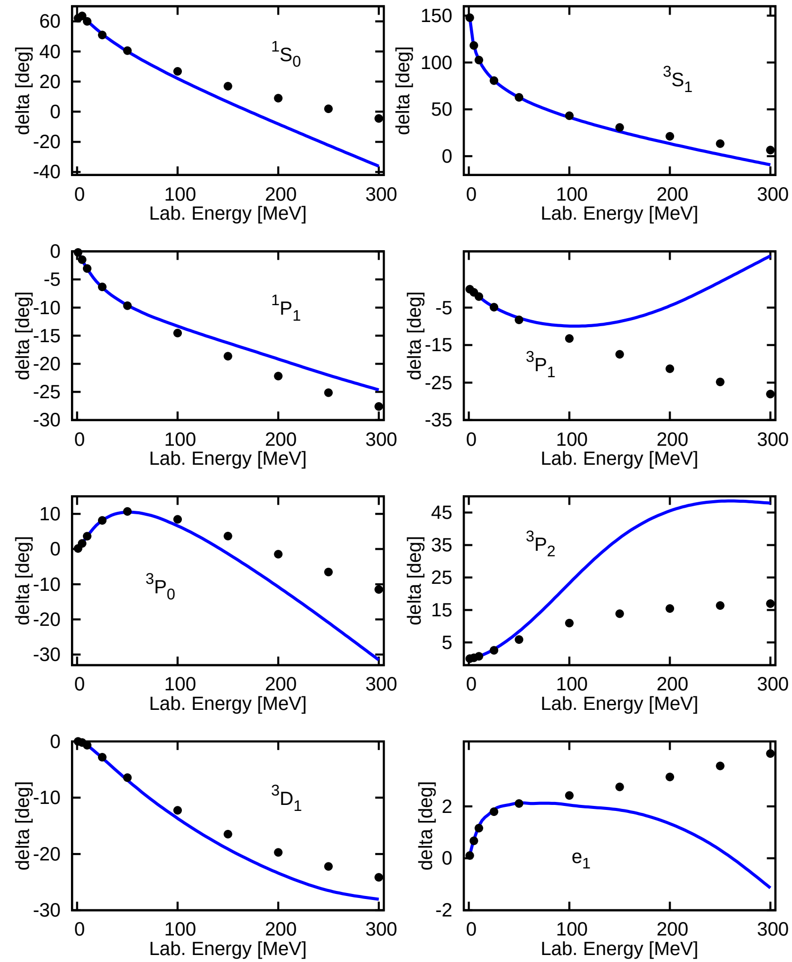
$$
\begin{aligned}
V_{eff} &= V_{OPEP} + V^{(0)} + V^{(2)} \,, \\
V_{OPEP} &= -\left(\frac{g_A}{2F_\pi}\right)^2 \frac{\vec{\tau_1}\cdot\vec{\tau_2}\vec{\sigma_1}\cdot\vec{q}\vec{\sigma_2}\cdot\vec{q}}{q^2+M_\pi^2} \\
V^{(0)} &= C_S + C_T\vec{\sigma_1}\cdot\vec{\sigma_2} \\
V^{(2)} &= C_1\vec{q}^2 + C_2\vec{k}^2 + (C_3\vec{q}^2 + C_4\vec{k}^2)\vec{\sigma_1}\cdot\vec{\sigma_2} \\
&\quad + iC_5\frac{1}{2}(\vec{\sigma_1}+\vec{\sigma_2})\cdot\vec{k}\times\vec{q} \\
&\quad + C_6\vec{\sigma_1}\cdot\vec{q}\vec{\sigma_2}\cdot\vec{q} + C_7\vec{\sigma_1}\cdot\vec{k}\vec{\sigma_2}\cdot\vec{k} \\
V^{(0)} &= C_S - \frac{1}{4}A[C_S - 3C_T]\,x\,(x-1) \\
&+ \vec{\sigma_1}\cdot\vec{\sigma_2}\left(C_T + \frac{1}{4}A[C_S - 3C_T]x(x-1)\right) \\
x &= (\rho/\rho_c)^{\frac{1}{3}}
\end{aligned}
\tag{1}
$$

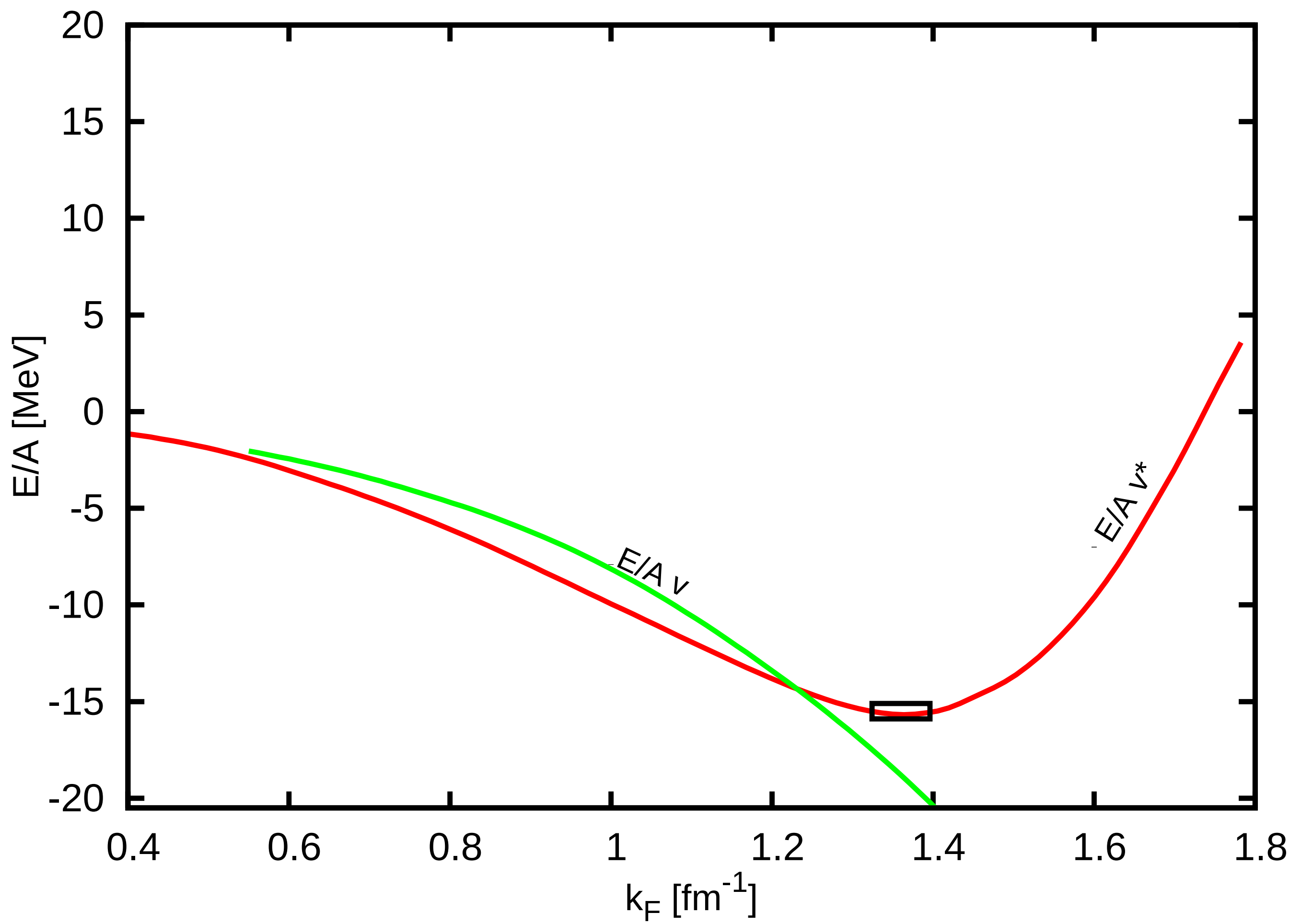
Density dependent LEC??





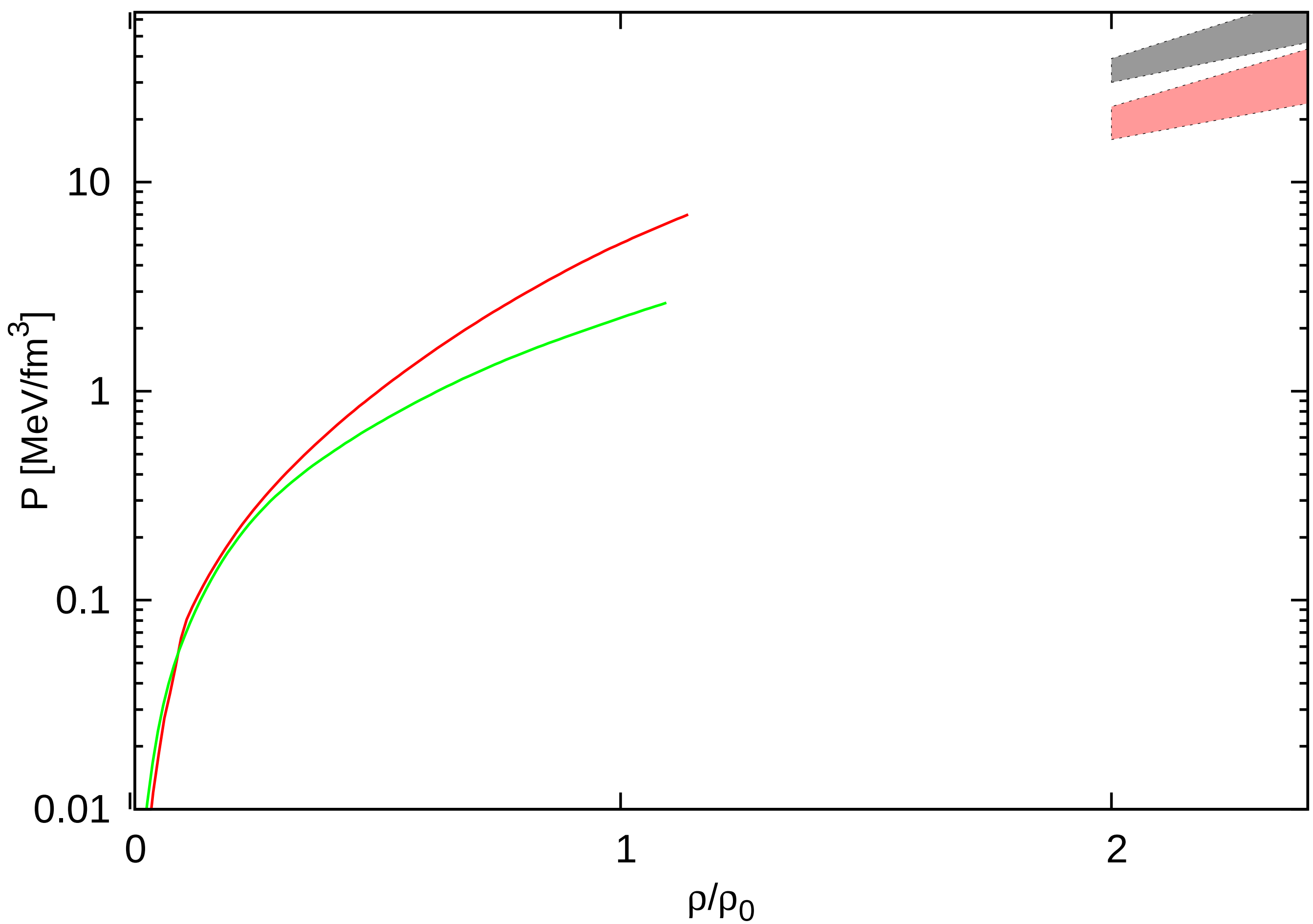
Nuclear matter NNLO(550)

$\Lambda = 550$ MeV



Pressure Neutron Matter

$\Lambda = 550$ MeV



Conclusions

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NLO Saturation curve cut off independent below 0.5 fm^{-1}.

Effective Field Theory produces saturation of nuclear matter at NLO, but saturation point strongly cut off dependent.

NNLO Saturation curve cut off independent below 1.0 fm^{-1}.

The relevance of four-body interactions for saturation cannot be ruled out.

EFT requires treatment of three-body correlations.

OUTLOOK: Neutron-rich short-lived isotopes, Obninsk, St.Peterburg.