Lecture T3b

(1) Normal-ordering: density-dependent interactions, residual 3-body forces
→ 3N forces and exotic nuclei preview

(2) Neutron matter based on chiral EFT interactions

(3) Impact on astrophysics

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(3) Neutron matter based on chiral EFT interactions

Neutron matter: What we know so far: $n = \frac{k_F^3}{3\pi^2}$

- Low densities $k_F r_e \ll 1$ nonperturbative due to large scattering length
  → close to unitary limit $\frac{E}{N} = \xi \frac{3}{5}\frac{k_F^2}{2m}$ with universal Bertsch parameter

  for $\frac{1}{k_F a} = 0$ $\xi = 0.37$ $E_{int} = -0.63\, E_{kin}$

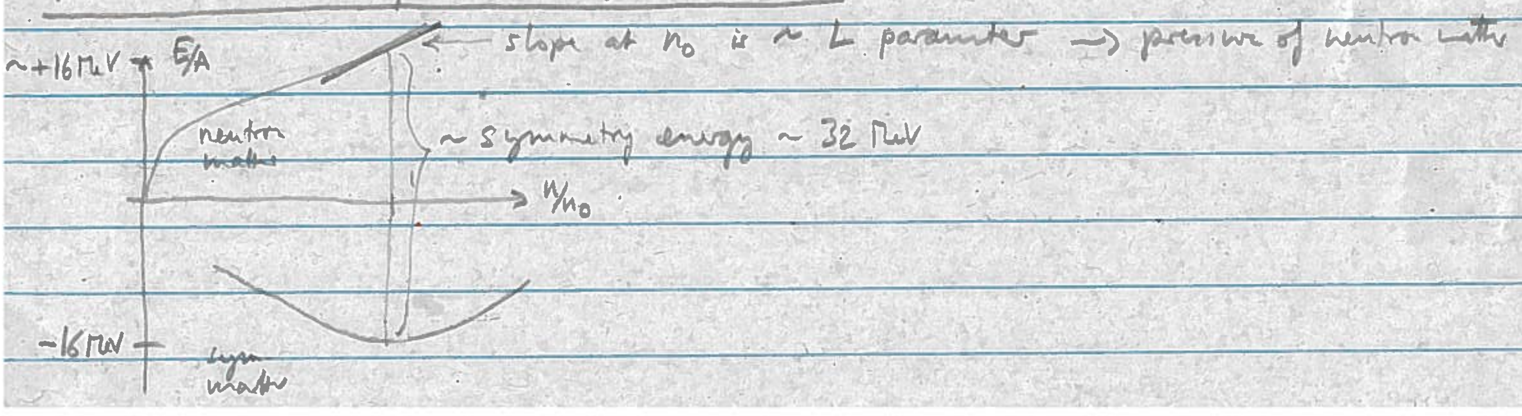
  Q: Which density is $k_F r_e = \frac{1}{2}$? $n = \frac{k_F^3}{3\pi^2} \sim \frac{1}{30}\frac{1}{8}\,\text{fm}^{-3} \sim \frac{1}{40} n_0$ with saturation density $n_0 = \frac{1}{6}\,\text{fm}^{-3}$

- nuclear densities $n \sim \left(\frac{1}{10} - 1\right) n_0$ expect more perturbative from Weinberg eigenvalues for low-momentum interactions

- high densities $n \gg n_0$ beyond chiral EFT new degrees of freedom possible hyperons, kaons, quarks, ...

  unclear whether exotic phases are reached in astrophysical conditions

Neutron matter vs symmetric (N=Z) nuclear matter



Ground state of low-density neutron matter is homogeneous.

vs. low-density symmetric matter clusters into low-density neutron gas
+ nuclei with central densities $\sim n_0$, so maximal B/A