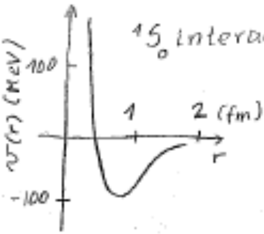
Quantality parameter ratio of quantal kinetic energy of localization and potential energy; $\boxed{\text{box 1}}$

App. 2.A



$$Q = \frac{\hbar^2}{M_n a^2}\frac{1}{|v_0|}\,;\; M_n = 0.939\ \mathrm{GeV}/c^2$$ (neutron mass)

$a \approx 1$ fm (range)

$v_0 \approx -100$ MeV (depth)

$^1S_0$: interaction between two nucleons in states of time reversal with $S=L=0$, and thus in a singlet state.

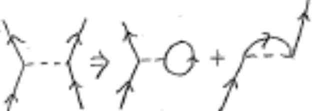
(QM: ZPF ($\Delta p \Delta x \gtrsim \hbar$) $\frac{\hbar^2}{Ma^2}$)

constituents	M/M_n	a (cm)	v_0 (eV)	Q	phase (T=0)	T_c
^3He	3	2.9 (-8)	8.6 (-4)	0.19	liquid [a)]	
^4He	4	2.9 (-8)	8.6 (-4)	0.14	liquid [a)]	
H_2	2	3.3 (-8)	32 (-4)	0.06	solid [a)]	
^{20}Ne	20	3.1 (-8)	31 (-4)	0.007	solid	
nucleons	1	9 (-14)	100 (+6)	0.5 [c)]	liquid [a,b)]	

a) liquid (condensed)
b) better, Non-Newtonian solid
c) Nucleus, paradigm of quantal many-body Fermi systems.

(B.R. Mottelson, Elementary features of nuclear structure, Les Houches, Session LXVI, Elsevier (1998))

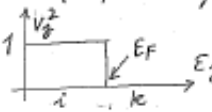
Fluctuations, quantal or classical, favor symmetry: gases and liquids are homogenous. Potential energy on the other hand prefers special arrangements: atoms like to be at specific distances from each other (spontaneous breaking of symmetry).



$$U(r) = \int d^3r'\,\rho(r')\,v(|r-r'|)$$

$$\rho(r) = \sum_i |\varphi_i(\vec r)|^2$$

$$U_x = -\sum_i \varphi_i^*(\vec r')\,v(|\vec r-\vec r'|)\,\varphi_i(\vec r)$$



For $Q \gtrsim 0.15$ independent-particle motion.