Self-consistent weak P-odd nucleon potential within the generalized Fermi-liquid theory

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Helmholtz International Summer School
„Nuclear Theory and Astrophysical Applications" –
NTAA'07, Dubna, Russia, August 7-17, 2007

1 Introduction

a Single-nucleon HF-potential for realistic NN-interaction in the frames of the generalized Fermi-liquid theory

$$V^{HF}(1,\hat{\vec{k}}_1) = V^H(1) + V^F(1,\hat{\vec{k}}_1) = V^H(1) + \int V^F(1,2)\, e^{i\vec{r}\hat{\vec{k}}_1} d2\,;$$

$$V^H(1) = \int \lim_{2'\to 2} \left(v(1,2)\tilde{\rho}(2,2')\right) d2, \quad V^F(1,2) = -\lim_{2'\to 2}\left(v(1,2)\tilde{\rho}(1,2')\right)$$

$V^{HF} \equiv \hat{\Sigma}_0 \rightarrow$ **non-retarding part of the nucleon mass operator.**

($1 \equiv (\vec{r}_1, \vec{\sigma}_1, \vec{\tau}_1)$, $2 \equiv (\vec{r}_2, \vec{\sigma}_2, \vec{\tau}_2)$, $v(1,2)$ – realistic NN-forces, $\tilde{\rho}(1,2)$ – exact single-nucleon density matrix, $\vec{r} = \vec{r}_2 - \vec{r}_1$, $d2 \rightarrow$ integration $d^3\vec{r}_2$ + summation over $\vec{\sigma}, \vec{\tau}$ – indexes of the second nucleon, $\hat{\vec{k}}_1 = -i\vec{\nabla}_1$, $\exp(i\vec{r}\hat{\vec{k}}_1)$ – space shift operator)

The former cycle of 6 papers (S.G. Kadmensky, V.V. Lyuboshitz et al, Yad. Fiz. and Izv. RAN (ser. fiz.), 1993–1996) – construction and calculations of $V^{HF}(1,\hat{\vec{k}}_1)$ (coinciding with the self-consistent nucleon potential and with the real part of the nucleon optical potential) in nuclear matter and finite spherical nuclei (^{208}Pb, ^{40}Ca) for the case of usual P-even strong NN-interaction of general form $\Rightarrow$

$\Rightarrow$ in particular: quite satisfactory agreement with most of the parameters of phenomenological nucleon optical potentials for several primary sets of strong NN-forces.

б) Primary weak parity-violating NN-interaction

[B. Desplanques, Phys. Reports, 297, 1 (1998)]

Framework implied: a) T-invariance conservation

б) only one-meson exchanges by the lightest mesons (π, ρ, ω)

Representation (most suitable for nuclear HF-calculations and for nuclear physics purposes on the whole):

a) the usual unit system (instead of original $[\hbar = c = 1]$)

б) redefinition of τ_z: $\tau_z = \begin{cases} +1, & \text{neutron} \\ -1, & \text{proton} \end{cases}$

$$v^{PV}(1,2) = \sum_j v_j^{PV}(1,2) \qquad (j = \pi, \rho, \omega);$$

$$v^{PV}_\pi(1,2) = -\frac{\hbar^2}{M_N}\frac{i}{2\sqrt{2}}\, g_\pi h_\pi^{(1)} (\vec\tau_1 \times \vec\tau_2)_z (\vec\sigma_1 + \vec\sigma_2)\left[\frac{\hat{\vec k}_1 - \hat{\vec k}_2}{2}, f_\pi(r)\right];$$

$$v^{PV}_\rho(1,2) = -\frac{\hbar^2}{M_N}\, g_\rho \left(h_\rho^{(0)}\vec\tau_1\vec\tau_2 - h_\rho^{(1)}\frac{\tau_{1z}+\tau_{2z}}{2} + h_\rho^{(2)}\frac{3\tau_{1z}\tau_{2z} - \vec\tau_1\vec\tau_2}{2\sqrt{6}}\right)\times$$

$$\times\left((\vec\sigma_1 - \vec\sigma_2)\left\{\frac{\hat{\vec k}_1 - \hat{\vec k}_2}{2}, f_\rho(r)\right\} + i(1+\chi_\rho)(\vec\sigma_1 \times \vec\sigma_2)\left[\frac{\hat{\vec k}_1 - \hat{\vec k}_2}{2}, f_\rho(r)\right]\right) -$$

$$-\frac{\hbar^2}{M_N}\, g_\rho h_\rho^{(1)}\frac{\tau_{1z}-\tau_{2z}}{2}(\vec\sigma_1 + \vec\sigma_2)\left\{\frac{\hat{\vec k}_1 - \hat{\vec k}_2}{2}, f_\rho(r)\right\} +$$

$$+\frac{\hbar^2}{2M_N}\, i g_\rho h_\rho^{(1)\prime} (\vec\tau_1 \times \vec\tau_2)_z (\vec\sigma_1 + \vec\sigma_2)\left[\frac{\hat{\vec k}_1 - \hat{\vec k}_2}{2}, f_\rho(r)\right];$$

$$\underline{v_{\omega}^{PV}(1,2)} = -\frac{\hbar^2}{M_N} g_\omega \left(h_\omega^{(0)} - h_\omega^{(1)} \frac{\tau_{1z}+\tau_{2z}}{2} \right) \times$$

$$\times \left((\vec{\sigma}_1 - \vec{\sigma}_2) \left\{ \frac{\hat{\vec{k}}_1 - \hat{\vec{k}}_2}{2}, f_\omega(r) \right\} + i(1+\chi_\omega)(\vec{\sigma}_1 \times \vec{\sigma}_2) \left[\frac{\hat{\vec{k}}_1 - \hat{\vec{k}}_2}{2}, f_\omega(r) \right] \right) +$$

$$+ \frac{\hbar^2}{M_N} g_\omega h_\omega^{(1)} \frac{\tau_{1z}-\tau_{2z}}{2} (\vec{\sigma}_1 + \vec{\sigma}_2) \left\{ \frac{\hat{\vec{k}}_1 - \hat{\vec{k}}_2}{2}, f_\omega(r) \right\} .$$

(Notations: $[\ldots.]$ - commutator, $\{\ldots.\}$ - anticommutator, $\hat{\vec{k}} = -i\vec{\nabla}$, $f_j(r) = \exp\left(-\frac{m_j c}{\hbar} r\right) \Big/ 4\pi r$ - meson formfactors ($m_\rho \approx m_\omega \approx m_v$); M_N - nucleon mass; $\chi_\rho = \mu_p - \mu_n - 1$; $\chi_\omega = \mu_p + \mu_n - 1$ ($\mu_{p,n}$ - nucleon magnetic moments); g_j - strong meson-nucleon coupling constants; h_j - weak parity-nonconserving meson-nucleon coupling constants).

A set of 7 weak meson-nucleon constants:

$\left(h_\pi^{(1)}, h_\rho^{(0)}, h_\rho^{(1)}, h_\rho^{(1)\prime}, h_\rho^{(2)}, h_\omega^{(0)}, h_\omega^{(1)} \right)$ - theoretically predicted and determined on the basis of various approaches (in particular, from the nucleon quark model)

different models $\Longrightarrow$ different predictions for each of h_j, in general

but:

(in most of the known sets $h_\rho^{(1)\prime} = 0$)

The weak single-nucleon HF-potential for finite nuclei, constructed on the basis of PNC-interaction $v^{PV}(1,2)$, is the theoretical weak P-odd nucleon-nucleus potential.

Recent works:

S. G. Kadmensky, V. V. Lyuboshitz, Yu. M. Tchuvil'sky.
Proceedings of ISINN-9, JINR E3-2001-192, Dubna, 2001, p. 141;
Proceedings of ISINN-10, JINR E3-2003-10, Dubna, 2003, p. 103

- 1) general construction of the weak single-nucleon HF-potential V_W^{HF} on the basis of parity-nonconserving NN-forces;
2) calculations for ^{208}Pb, ^{40}Ca with one characteristic fixed set of weak meson-nucleon constants h_j:

$$h_\pi^{(1)} = 1.3 \cdot 10^{-7};\ h_\rho^{(0)} = -8.3 \cdot 10^{-7};\ h_\rho^{(1)} = 3.9 \cdot 10^{-8};$$
$$h_\rho^{(1)'} = 0,\ h_\rho^{(2)} = -6.7 \cdot 10^{-7};\ h_\omega^{(0)} = -3.9 \cdot 10^{-7};\ h_\omega^{(1)} = -2.2 \cdot 10^{-7}$$

[V. M. Dubovik, S. V. Zenkin, Ann. Phys. 172, 100 (1986)]

3) comparison with the weak phenomenological nucleon-nucleus potentials V_W^{ph}:

a) obvious resemblance of V_W^{HF} and V_W^{ph} in the general structure (although V_W^{HF} has, naturally, a more complicated form with some additional features)

b) for some components of V_W^{HF} the calculated values fit the respective phenomenological ones quite well;

however: for other components there is a noticeable disagreement in magnitudes.

 [S. G. Kadmensky, V. V. Lyuboshitz, Proceedings of ISINN-11, JINR E3-2004-9, Dubna, 2004, p. 252.

Aims of the present work: 1) to perform the calculations of V_w^{HF} with several other sets of weak meson-nucleon constants h_j and to study the dependence of various terms in V_w^{HF} upon h_j; 2) to test these new sets just as the initial one, comparing the results for various components of V_w^{HF} with the respective values for weak phenomenological nucleon-nucleus potentials V_w^{ph}.

2 General structure of the weak single-nucleon HF-potential for finite spherical nuclei

$$V_w^{HF}(1,\hat{\vec{k}}_1) = \int \lim_{2'\to 2}\left(v^{PV}(1,2)\tilde{\rho}(2,2')\right)d2 - \int \lim_{2'\to 2}\left(v^{PV}(1,2)\tilde{\rho}(1,2')\right)e^{i\vec{r}\hat{\vec{k}}_1}d2 =$$

$$= W^{HF}(\tilde{1},\hat{\vec{k}}_1)(\vec{\sigma}_1\hat{\vec{k}}_1) + i\vec{\sigma}_1\vec{V}_{gr}^{HF}(\vec{r}_1,\tau_{1z},\hat{\vec{k}}_1). \qquad (\tilde{1}\equiv(r_1,\tau_{1z}))$$

Here:

1) $W^{HF}(\tilde{1},\hat{\vec{k}}_1) = \sum\limits_{j=\pi,\rho,\omega}\left(W_j^H(\tilde{1}) + W_j^F(\tilde{1},\hat{\vec{k}}_1)\right)$, where

$$W_\pi^H \equiv 0; \qquad W_\rho^H(\tilde{1}) = \frac{\hbar^2}{2M_N} g_\rho\left(h_\rho^{(1)} - \tau_{1z}\left(h_\rho^{(0)} + \frac{h_\rho^{(2)}}{\sqrt{6}}\right)\right)C_\rho^{H(\tau)}(r_1);$$

$$W_\omega^H(\tilde{1}) = -\frac{\hbar^2}{2M_N} g_\omega\left(h_\omega^{(0)} - \tau_{1z}h_\omega^{(1)}\right)C_\omega^H(r_1);$$

$$W_\pi^F(\tilde{1},\hat{\vec{k}}_1) = \frac{\hbar^2}{M_N}\frac{g_\pi h_\pi^{(1)}}{4\sqrt{2}}\left(C_\pi^{F(\tau)}(r_1,\hat{\vec{k}}_1) - \tau_{1z}C_\pi^F(r_1,\hat{\vec{k}}_1)\right);$$

$$W^F_\rho(\tilde{1},\hat{\vec{k}}_1) = -\frac{\hbar^2}{4M_N}(1+\chi_\rho)g_\rho\Big[C^F_\rho(r_1,\hat{\vec{k}}_1)\Big(3h^{(0)}_\rho - \tilde{\tau}_{1z}\Big(h^{(1)}_\rho + \frac{h^{(1)'}_\rho}{1+\chi_\rho}\Big)\Big) - C^{F(\tau)}_\rho(r_1,\hat{\vec{k}}_1)\Big(h^{(1)}_\rho - \frac{h^{(1)'}_\rho}{1+\chi_\rho} - \tilde{\tau}_{1z}\Big(\sqrt{\tfrac{2}{3}}\,h^{(2)}_\rho - h^{(0)}_\rho\Big)\Big)\Big];$$

$$W^F_\omega(\tilde{1},\hat{\vec{k}}_1) = -\frac{\hbar^2}{4M_N}(1+\chi_\omega)g_\omega\Big[C^F_\omega(r_1,\hat{\vec{k}}_1)\big(h^{(0)}_\omega - \tilde{\tau}_{1z}h^{(1)}_\omega\big) - C^{F(\tau)}_\omega(r_1,\hat{\vec{k}}_1)\big(h^{(1)}_\omega - \tilde{\tau}_{1z}h^{(0)}_\omega\big)\Big].$$

Here C_j – scalar integral convolutions of meson formfactors with the single-nucleon density matrix: $(f_\rho \approx f_\omega \approx f_v)$

$$C^H_j(r_1) = \int f_j(r)\rho(r_2)\,d^3\vec{r}_2;\quad C^{H(\tau)}_j(r_1) = \int f_j(r)\rho_\tau(r_2)\,d^3\vec{r}_2;$$

$$C^F_j(r_1,\hat{\vec{k}}_1) = \int f_j(r)\tilde{\rho}(\vec{r}_1,\vec{r}_2)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2;\quad C^{F(\tau)}_j(r_1,\hat{\vec{k}}_1) = \int f_j(r)\tilde{\rho}_\tau(\vec{r}_1,\vec{r}_2)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2,$$

$\big(\rho_{n,p}(r_2) \equiv \tilde{\rho}_{n,p}(\vec{r}_2,\vec{r}_2)$ – single-nucleon density; $\left(\begin{matrix}\rho = \rho_n + \rho_p;\ \rho_\tau = \rho_n - \rho_p\\ \tilde{\rho} = \tilde{\rho}_n + \tilde{\rho}_p;\ \tilde{\rho}_\tau = \tilde{\rho}_n - \tilde{\rho}_p\end{matrix}\right);$ $\tilde{\tau}_{1z} = \begin{cases}+1, & n\\ -1, & p\end{cases}\big).$

2) $$\vec{V}^{HF}_{gr}(\vec{r}_1,\tilde{\tau}_{1z},\hat{\vec{k}}_1) = \sum_{j=\pi,\rho,\omega}\Big(\vec{V}^H_{j(gr)}(\vec{r}_1,\tilde{\tau}_{1z}) + \vec{V}^F_{j(gr)}(\vec{r}_1,\tau_{1z},\hat{\vec{k}}_1)\Big),$$

where: $\vec{V}^H_{\pi(gr)} \equiv 0;$

$$\vec{V}^H_{\rho(gr)}(\vec{r}_1,\tau_{1z}) = \frac{\hbar^2}{M_N}g_\rho\Big(h^{(1)}_\rho - \tau_{1z}\Big(h^{(0)}_\rho + \frac{h^{(2)}_\rho}{\sqrt{6}}\Big)\Big)\Big(\frac{1}{4}\vec{D}^{H(\tau)}_{\rho(1)}(\vec{r}_1) + \vec{D}^{H(\tau)}_{\rho(2)}(\vec{r}_1)\Big);$$

$$\vec{V}^H_{\omega(gr)}(\vec{r}_1,\tau_{1z}) = -\frac{\hbar^2}{M_N}g_\omega\big(h^{(0)}_\omega - \tilde{\tau}_{1z}h^{(1)}_\omega\big)\Big(\frac{1}{4}\vec{D}^H_{\omega(1)}(\vec{r}_1) + \vec{D}^H_{\omega(2)}(\vec{r}_1)\Big);$$

$$\vec{V}^{F}_{\pi(g\tau)}(\vec{r}_1,\tau_{1z},\hat{\vec{k}}_1)=\frac{\hbar^2}{M_N}\,\frac{g_\pi h^{(1)}_{\pi}}{2\sqrt{2}}\Big[\frac{1}{2}\vec{D}^{F(\tau)}_{\pi(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F(\tau)}_{\pi(2)}(\vec{r}_1,\hat{\vec{k}}_1)-$$
$$-\tau_{1z}\Big(\frac{1}{2}\vec{D}^{F}_{\pi(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F}_{\pi(2)}(\vec{r}_1,\hat{\vec{k}}_1)\Big)\Big];$$

$$\vec{V}^{F}_{\rho(g\tau)}(\vec{r}_1,\tau_{1z},\hat{\vec{k}}_1)=-\frac{\hbar^2}{2M_N}(1+\chi_\rho)g_\rho\Big[\Big(\frac{1}{2}\vec{D}^{F}_{\rho(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F}_{\rho(2)}(\vec{r}_1,\hat{\vec{k}}_1)\Big)\Big(3h^{(0)}_{\rho}-\tau_{1z}\Big(h^{(1)}_{\rho}+\frac{h^{(1)\prime}_{\rho}}{1+\chi_\rho}\Big)\Big)$$
$$-\Big(\frac{1}{2}\vec{D}^{F(\tau)}_{\rho(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F(\tau)}_{\rho(2)}(\vec{r}_1,\hat{\vec{k}}_1)\Big)\Big(h^{(1)}_{\rho}-\frac{h^{(1)\prime}_{\rho}}{1+\chi_\rho}-\tau_{1z}\Big(\sqrt{\frac{2}{3}}h^{(2)}_{\rho}-h^{(0)}_{\rho}\Big)\Big)\Big]$$

$$\vec{V}^{F}_{\omega(g\tau)}(\vec{r}_1,\tau_{1z},\hat{\vec{k}}_1)=-\frac{\hbar^2}{2M_N}(1+\chi_\omega)g_\omega\Big[\Big(\frac{1}{2}\vec{D}^{F}_{\omega(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F}_{\omega(2)}(\vec{r}_1,\hat{\vec{k}}_1)\Big)\Big(h^{(0)}_{\omega}-\tau_{1z}h^{(1)}_{\omega}\Big)-$$
$$-\Big(\frac{1}{2}\vec{D}^{F(\tau)}_{\omega(1)}(\vec{r}_1,\hat{\vec{k}}_1)+\vec{D}^{F(\tau)}_{\omega(2)}(\vec{r}_1,\hat{\vec{k}}_1)\Big)\Big(h^{(1)}_{\omega}-\tau_{1z}h^{(0)}_{\omega}\Big)\Big].$$

Here $\vec{D}_{j(1)}$, $\vec{D}_{j(2)}$ – vector integral convolutions of
{ meson formfactors with the density matrix gradient,
{ meson formfactor gradients with the density matrix,
respectively:

$$\vec{D}^{H}_{j(1)}(\vec{r}_1)=\int f_j(r)\big(\vec{\nabla}_2\rho(r_2)\big)d^3\vec{r}_2;\qquad \vec{D}^{H(\tau)}_{j(1)}(\vec{r}_1)=\int f_j(r)\big(\vec{\nabla}_2\rho_\tau(r_2)\big)d^3\vec{r}_2;$$
$$\vec{D}^{H}_{j(2)}(\vec{r}_1)=\int\big(\vec{\nabla}_r f_j(r)\big)\rho(r_2)\,d^3\vec{r}_2;\qquad \vec{D}^{H(\tau)}_{j(2)}(\vec{r}_1)=\int\big(\vec{\nabla}_r f_j(r)\big)\rho_\tau(r_2)\,d^3\vec{r}_2;$$
$$\vec{D}^{F}_{j(1)}(\vec{r}_1,\hat{\vec{k}}_1)=\int f_j(r)\big(\vec{\nabla}_1\tilde{\rho}(\vec{r}_1,\vec{r}_2)\big)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2;\qquad \vec{D}^{F(\tau)}_{j(1)}(\vec{r}_1,\hat{\vec{k}}_1)=\int f_j(r)\big(\vec{\nabla}_1\tilde{\rho}_\tau(\vec{r}_1,\vec{r}_2)\big)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2;$$
$$\vec{D}^{F}_{j(2)}(\vec{r}_1,\hat{\vec{k}}_1)=\int\big(\vec{\nabla}_r f_j(r)\big)\tilde{\rho}(\vec{r}_1,\vec{r}_2)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2;\qquad \vec{D}^{F(\tau)}_{j(2)}(\vec{r}_1,\hat{\vec{k}}_1)=\int\big(\vec{\nabla}_r f_j(r)\big)\tilde{\rho}_\tau(\vec{r}_1,\vec{r}_2)e^{i\vec{r}\hat{\vec{k}}_1}d^3\vec{r}_2.$$

(all the notations are the same as for C_j)

Further consideration: $\vec{V}^{HF}_{gr}$ $\Rightarrow$ Hartree and zero-order Fock terms ($\hat{\vec{k}}_1 \to 0$, $\exp(i\vec{r}\hat{\vec{k}}_1) \to 1$) only.

Spherical symmetry of the nucleus $\Rightarrow \begin{pmatrix} (\vec{r}_1, \vec{r}_2) \to (\vec{r}_1, \vec{r}) \\ d^3\vec{r}_2 \to d^3\vec{r} \\ z \parallel \vec{r}_1 \end{pmatrix} \Rightarrow$ transformations of $\vec{D}_{j(1,2)}$:

$$\vec{D}^H_{j(1)}(\vec{r}_1) = \vec{e}_{r_1} \int f_j(r) \left(\frac{r_1 + r\eta}{r_2}\right) \frac{d\rho(r_2)}{dr_2} d^3\vec{r}; \quad \vec{D}^H_{j(2)}(\vec{r}_1) = \vec{e}_{r_1} \int \frac{df_j(r)}{dr} \rho(r_2)\eta\, d^3\vec{r};$$

$$\vec{D}^F_{j(1)}(\vec{r}_1, 0) = \vec{e}_{r_1} \int f_j(r) \left(\frac{\partial^2 \tilde{\rho}(\vec{r}_1, \vec{r})}{\partial r_1} - \eta \frac{\partial \tilde{\rho}(\vec{r}_1, \vec{r})}{\partial r} - \frac{1-\eta^2}{r} \frac{\partial \tilde{\rho}(\vec{r}_1, \vec{r})}{\partial \eta} \right) d^3\vec{r};$$

$$\vec{D}^F_{j(2)}(\vec{r}_1, 0) = \vec{e}_{r_1} \int \frac{df_j(r)}{dr} \tilde{\rho}(\vec{r}_1, \vec{r})\eta\, d^3\vec{r} \qquad (\text{for } \vec{D}^{(\tau)}_{j(1,2)} - \text{analogously}).$$

$\left(\vec{e}_{r_1} = \vec{r}_1 / r_1;\ \eta = \cos(\widehat{\vec{r}_1, \vec{r}});\ r_2 = |\vec{r}_1 + \vec{r}| = \sqrt{r_1^2 + r^2 + 2r_1 r \eta};\ \tilde{\rho}(\vec{r}_1, \vec{r}) = \tilde{\rho}(r_1, r, \eta)\right)$

Explicit surface character of all integrals in $\vec{D}^{(H,F)}_{j(1,2)}$.

$$\vec{V}^H_{j(gr)}(\vec{r}_1, \tau_{1z}) = \vec{e}_{r_1} V^H_{j(sf)}(\tilde{1}); \quad \vec{V}^F_{j(gr)}(\vec{r}_1, \tau_{1z}, 0) = \vec{e}_{r_1} V^F_{j(sf)}(\tilde{1}); \quad \left(\begin{matrix} j = \pi, \rho, \omega; \\ \tilde{1} \equiv (r_1, \tau_{1z}) \end{matrix} \right)$$

$\Rightarrow$ eventually:

$$\boxed{V^{HF}_W(1, \hat{\vec{k}}_1) \approx W^{HF}(\tilde{1}, \hat{\vec{k}}_1)(\vec{\sigma}_1 \hat{\vec{k}}_1) + i(\vec{\sigma}_1 \vec{e}_{r_1}) V^{HF}_{sf}(\tilde{1})},$$

where $\vec{e}_{r_1} V^{HF}_{sf}(\tilde{1}) = \vec{V}^{HF}_{gr}(\vec{r}_1, \tau_{1z}, 0)$ (i.e. $V^{HF}_{sf}(\tilde{1}) = \vec{e}_{r_1} \vec{V}^{HF}_{gr}(\vec{r}_1, \tau_{1z}, 0)$).

$\left(V^{HF}_{sf}(\tilde{1}) = V^{HF}_{sf(1)}(\tilde{1}) + V^{HF}_{sf(2)}(\tilde{1}); \quad \begin{matrix} V^{HF}_{sf(1)} \to \text{terms with } \vec{D}^H_{j(1)}, \vec{D}^F_{j(1)}; \\ V^{HF}_{sf(2)} \to \text{terms with } \vec{D}^H_{j(2)}, \vec{D}^F_{j(2)}. \end{matrix} \right)$

The case of $N=Z$ $\Rightarrow$ essential simplification of V_W^{HF}:

$\rho_\tau = \tilde{\rho}_\tau \equiv 0 \Rightarrow \left(C_j^{(\tau)} \equiv 0,\ \vec{D}^{(\tau)}_{j(1,2)} \equiv 0 \right) \Rightarrow$ in particular:

1) $W_\rho^H \equiv 0,\ V^H_{\rho(sf)} \equiv 0 \Rightarrow$ the weak Hartree potential is determined by the ω-meson exchange exclusively (weak constants $h^{(0)}_\omega, h^{(1)}_\omega$);

2) π-meson Fock terms $W^F_\pi, V^F_{\pi(sf)}$ retain only the isovector part (isoscalar $\to 0$)

3) V_W^{HF} loses entirely the dependence on $h_\rho^{(2)}$ (which is observed, in the general case, in all isovector ρ-meson terms).

3 Results of calculations

a Guidelines

1. ^{40}Ca $(N=Z)$ $\Rightarrow$ further easy comparison with well-known weak phenomenological nucleon-nucleus potentials for $N=Z$

2. total density: $\rho(r_1) = 2\rho_n(r_1) = 2\rho_p(r_1) = \rho_0 \left(1 + \exp\left(\frac{r_1 - R_A}{a_0}\right)\right)^{-1}$
   $\left(a_0 = 0.54\ Fm;\ R_A = 1.1 A^{1/3}\ Fm \approx 3.76\ Fm;\ \rho_0 = 0.17\ Fm^{-3}\right)$

3. $\tilde{\rho}_{n,p}(\vec{r}_1, \vec{r}_2) \to$ quasiclassical approximation $\Rightarrow$

$$\Rightarrow \tilde{\rho}(\vec{r}_1,\vec{r}_2) = 2\tilde{\rho}_n(\vec{r}_1,\vec{r}_2) = 2\tilde{\rho}_p(\vec{r}_1,\vec{r}_2) = \frac{4}{(2\pi)^3}\int_0^{\tilde{k}_f(R)} e^{-i\vec{k}\vec{r}}\, d^3\vec{k} = \frac{2\tilde{k}_f^2(R)}{\pi^2 r} j_1(\tilde{k}_f(R) r)$$

$$\left(R = \frac{1}{2}|\vec{r}_1 + \vec{r}_2|;\ \tilde{k}_f(R) = k_f^n(R) = k_f^p(R) = \left(\frac{3}{2}\pi^2 \rho(R)\right)^{1/3} \right)$$

4. $m_\rho \approx m_\omega \approx m_v$; $g_\pi = 13.4$; $g_\rho = 2.55$; $g_\omega = 7.65$;
   $\chi_\rho = 3.7$; $\chi_\omega = -0.12$.

5 4 different sets of weak constants h_j (presented in the review: [B. Desplanques, Phys. Reports, 297, 1 (1998)]

The values of h_j (in the units of 10^{-7})

	$h_\pi^{(1)}$	$h_\rho^{(0)}$	$h_\rho^{(1)}$	$h_\rho^{(1)'}$	$h_\rho^{(2)}$	$h_\omega^{(0)}$	$h_\omega^{(1)}$
I	4.6	-11.4	-0.2	0	-9.5	-1.9	-1.1
II	1.65	-7.4	-0.15	0	-8.2	-5.55	-2.0
III	0.45	-11.25	-0.1	0	-10.3	-3.85	-1.55
IV	0.2	-3.7	-0.1	-2.2	-3.3	-6.2	-1.0
DZ	1.3	-8.3	0.39	0	-6.7	-3.9	-2.2

I – DDH „best values" [B. Desplanques, J. F. Donoghue, B. R. Holstein, Ann. Phys. 124, 449 (1980)]

II, III – the mean values of two ranges for h_j derived within two different models in [B. Desplanques, Nucl. Phys. A335, 147 (1980)]

IV – one of the characteristic sets from the cycle of works: [N. Kaiser, U. G. Meissner, Nucl. Phys. A489, 671 (1988), A499, 699 (1989), A510, 759 (1990)]

(DZ – values for the previously used set of Dubovik and Zenkin (for comparison);

$h_\rho^{(1)'} \neq 0$ for the set IV only;

the values of $h_\rho^{(2)}$ – for information (no influence on V_W^{HF} for $N=Z$))

b) Results for the main pseudoscalar term of V_w^{HF}.

$$W^{HF}(1,\hat{\vec{k}}_1)(\vec{\sigma}_1\hat{\vec{k}}_1) \approx \left(W_0^{HF}(1)+\gamma(1)\hat{\vec{k}}_1^{\,2}\right)(\vec{\sigma}_1\hat{\vec{k}}_1) =$$

$$= \left(W_0^{HF}(r_1)+\gamma(r_1)\hat{\vec{k}}_1^{\,2}+\tau_{1z}\left(\tilde{W}_0^{HF}(r_1)+\tilde{\gamma}(r_1)\hat{\vec{k}}_1^{\,2}\right)\right)(\vec{\sigma}_1\hat{\vec{k}}_1)$$

(approximation of the second order of $\hat{\vec{k}}_1$ for the Fock potential; the small first-order surface components are omitted; $\tau_{1z}=\begin{cases}+1, & n\\ -1, & p\end{cases}$)

The values for $r_1=0$.

		W^H	W_0^F	W_0^{HF}	γ	$\tilde{W}^H$	$\tilde{W}_0^F$	$\tilde{W}_0^{HF}$	$\tilde{\gamma}$
I	π	—	—	—	—	—	-5.353	-5.353	1.260
	ρ	—	4.213	4.213	-0.226	—	-0.025	-0.025	0.002
	ω	0.319	0.131	0.450	-0.007	-0.189	-0.076	-0.265	0.004
	total	0.319	4.344	4.663	-0.233	-0.189	-5.454	-5.643	1.266
II	π	—	—	—	—	—	-1.920	-1.920	0.452
	ρ	—	2.734	2.734	-0.146	—	-0.019	-0.019	0.001
	ω	0.932	0.384	1.316	-0.021	-0.344	-0.138	-0.482	0.008
	total	0.932	3.118	4.050	-0.167	-0.344	-2.077	-2.421	0.461
III	π	—	—	—	—	—	-0.524	-0.524	0.123
	ρ	—	4.157	4.157	-0.222	—	-0.012	-0.012	0.001
	ω	0.647	0.267	0.914	-0.015	-0.266	-0.107	-0.373	0.006
	total	0.647	4.424	5.071	-0.237	-0.266	-0.643	-0.909	0.130
IV	π	—	—	—	—	—	-0.233	-0.233	0.055
	ρ	—	1.367	1.367	-0.073	—	-0.070	-0.070	0.004
	ω	1.041	0.429	1.470	-0.024	-0.172	-0.069	-0.241	0.004
	total	1.041	1.796	2.837	-0.097	-0.172	-0.372	-0.544	0.063
DZ	π	—	—	—	—	—	-1.513	-1.513	0.356
	ρ	—	3.067	3.067	-0.164	—	0.048	0.048	-0.003
	ω	0.655	0.270	0.925	-0.015	-0.378	-0.152	-0.530	0.009
	total	0.655	3.337	3.992	-0.179	-0.378	-1.617	-1.995	0.362

(W^H, W_0^F, W_0^{HF}, $\tilde{W}^H$, $\tilde{W}_0^F$, $\tilde{W}_0^{HF}$) – in $eV\cdot Fm$; γ, $\tilde{\gamma}$ – in $eV\cdot Fm^3$; DZ-values calculated previously for the set of Dubovik and Zenkin (for comparison).

Main regularities observed:

1) Isoscalar Fock terms $W_0^F, \gamma \rightarrow$ strong prevalence of the ρ-meson contribution for all the new sets (just as for DZ). However: for the sets II, IV (larger absolute values of $h_\omega^{(0)}$: $h_\omega^{(0)} \sim -6 \cdot 10^{-7}$) $\rightarrow$ essential enhancement of the isoscalar Hartree term W^H and relative fraction of the ω-meson part in $W_0^F \Rightarrow$ in $W_0^{HF} \rightarrow$ very noticeable ω-meson constituent (for IV - even exceeding the ρ-meson one due to the smaller $h_\rho^{(0)}$).

2) Isovector Fock terms $\tilde{W}_0^F, \tilde{\gamma} \rightarrow$ obvious predominance of the π-meson part for all the sets (just as for DZ). However: for the sets III, IV (smaller values of $h_\pi^{(1)}$: $h_\pi^{(1)} \sim (0.2 \div 0.5) \cdot 10^{-7}$) $\rightarrow$ considerable increase of relative ω-meson fractions in $\tilde{W}_0^F$ and $\tilde{W}_0^{HF}$ (for IV: the ω-meson part in $\tilde{W}_0^{HF}$ even slightly exceeds the π-meson one!).

3) In all the considered cases the Fock terms strongly enhance the Hartree ones (having the same sign) for isoscalar as well as isovector components, just like for the DZ set (but: the relative contributions of W^H into W_0^{HF} and $\tilde{W}^H$ into $\tilde{W}_0^{HF}$ may noticeably increase or decrease, depending on the interrelation between weak constants $(h_\omega^{(0)}, h_\rho^{(0)})$ and $(h_\omega^{(1)}, h_\pi^{(1)})$, respectively.

4) For all the new sets (just as for DZ) the total terms $(W^H, \tilde{W}^H)$, W_0^F and $\tilde{W}_0^F$, and the total isoscalar and isovector coefficients $W_0^{HF}, \tilde{W}_0^{HF}$ have the mutually opposite signs. However: the ratio $|W_0^{HF} / \tilde{W}_0^{HF}|$ may be quite different, depending on the interrelation between weak constants (mainly, $h_\rho^{(0)}$ and $h_\pi^{(1)}$; but ω-meson terms $(\sim h_\omega^{(0)}, \sim h_\omega^{(1)})$ may also render a noticeable influence.); for the set I (contrary to others) $|\tilde{W}_0^{HF}| > W_0^{HF}$ due to the very large value of $h_\pi^{(1)}$.

Set IV → additional ρ-meson terms connected with $h_\rho^{(1)'} \neq 0$ (only in the Fock potential and only in its isovector components $\tilde{W}_0^F, \tilde{\gamma}$ for $N=Z$).

⇒ noticeable enhancement of the ρ-meson contribution into $\tilde{W}_0^F, \tilde{\gamma}$, as compared with the ordinary terms $\sim h_\rho^{(1)}$ ($W_\rho^{add} \approx 1.7\, W_\rho$); ⇒ (due to small $h_\omega^{(1)}$) equal ω- and ρ-meson parts in $\tilde{W}_0^F, \tilde{\gamma}$ (contrary to all the other sets), still remaining much smaller than the π-meson one.

E-dependence of the main pseudoscalar term:

$\vec{\hat{k}}_1^2 \approx \frac{2m}{\hbar^2}\left(E - V_{opt}(r_1, E)\right)$ → through the standard real part of phenomenological nucleon optical potential;

$V_{opt}(0, E) \approx -52 + 0.3E$ (MeV)

⇒ for $r_1 = 0$:

Set I: $W^{HF}(E) \approx 1.079 - 0.00787E$; $\tilde{W}^{HF}(E) \approx -2.468 + 0.0427E$

Set II: $W^{HF}(E) \approx 3.631 - 0.00564E$; $\tilde{W}^{HF}(E) \approx -1.265 + 0.0156E$

Set III: $W^{HF}(E) \approx 4.477 - 0.0080E$; $\tilde{W}^{HF}(E) \approx -0.583 + 0.00439E$

Set IV: $W^{HF}(E) \approx 2.594 - 0.00327E$; $\tilde{W}^{HF}(E) \approx -0.385 + 0.00214E$

(DZ: $W^{HF}(E) \approx 3.543 - 0.0060E$; $\tilde{W}^{HF}(E) \approx -1.087 + 0.0122E$)

$$\begin{cases} W^{HF}(E) = W^{HF}(E=0) + \beta E - \text{isoscalar components}; & W^{HF}, \tilde{W}^{HF} - \text{in eV}\cdot\text{Fm}; \\ \tilde{W}^{HF}(E) = \tilde{W}^{HF}(E=0) + \tilde{\beta} E - \text{isovector components}; & \beta, \tilde{\beta} - \text{in } 10^{-6}\,\text{Fm}; \; E - \text{in MeV} \end{cases}$$

For the sets III and IV with small values of $h_\pi^{(1)}$ → absolute E-dependence of the isovector component $\tilde{W}^{HF}(E)$ is weaker than that for $W^{HF}(E)$, contrary to I, II, DZ; but: the relative E-dependence of $\tilde{W}^{HF}(E)$ is much stronger in all cases

c) Results for the surface terms of V_W^{HF}

$$V_{sf}^{HF}(\tilde{1}) = V_{sf}^{HF}(r_1) + \tau_{1Z}\,\tilde{V}_{sf}^{HF}(r_1) =$$

$$= V_{sf(1)}^{HF}(r_1) + V_{sf(2)}^{HF}(r_1) + \tau_{1Z}\left(\tilde{V}_{sf(1)}^{HF}(r_1) + \tilde{V}_{sf(2)}^{HF}(r_1)\right)$$

((1) – contributions of components with the density matrix gradient (with $\vec{D}_{j(1)}^{H,F}$);
(2) – contributions of components with the meson formfactor gradient (with $\vec{D}_{j(2)}^{H,F}$);
$\tau_{1Z} = \begin{cases} +1, & n \\ -1, & p \end{cases}$).

The values of isoscalar components at $r_1 = R_A = 3.76$ Fm

		$V_{sf(1)}^{H}$	$V_{sf(1)}^{F}$	$V_{sf(1)}^{HF}$	$V_{sf(2)}^{H}$	$V_{sf(2)}^{F}$	$V_{sf(2)}^{HF}$	V_{sf}^{H}	V_{sf}^{F}	V_{sf}^{HF}
I	ρ	—	-0.993	-0.993	—	0.911	0.911	—	-0.082	-0.082
	ω	-0.068	-0.031	-0.099	0.270	0.028	0.298	0.202	-0.003	0.199
	total	-0.068	-1.024	-1.092	0.270	0.939	1.209	0.202	-0.085	0.117
II	ρ	—	-0.645	-0.645	—	0.591	0.591	—	-0.054	-0.054
	ω	-0.198	-0.091	-0.289	0.788	0.083	0.871	0.590	-0.008	0.582
	total	-0.198	-0.736	-0.934	0.788	0.674	1.462	0.590	-0.062	0.528
III	ρ	—	-0.980	-0.980	—	0.899	0.899	—	-0.081	-0.081
	ω	-0.137	-0.063	-0.200	0.547	0.057	0.604	0.410	-0.006	0.404
	total	-0.137	-1.043	-1.180	0.547	0.956	1.503	0.410	-0.087	0.323
IV	ρ	—	-0.322	-0.322	—	0.296	0.296	—	-0.026	-0.026
	ω	-0.221	-0.102	-0.323	0.881	0.092	0.973	0.660	-0.010	0.650
	total	-0.221	-0.424	-0.645	0.881	0.388	1.269	0.660	-0.036	0.624
DZ	ρ	—	-0.723	-0.723	—	0.663	0.663	—	-0.060	-0.060
	ω	-0.139	-0.064	-0.203	0.554	0.058	0.612	0.415	-0.006	0.409
	total	-0.139	-0.787	-0.926	0.554	0.721	1.275	0.415	-0.066	0.349

(all the values are in eV)

The values of isovector components at $r_1 = R_A = 3.76$ Fm

		$\tilde{V}^{H}_{sf(1)}$	$\tilde{V}^{F}_{sf(1)}$	$\tilde{V}^{HF}_{sf(1)}$	$\tilde{V}^{H}_{sf(2)}$	$\tilde{V}^{F}_{sf(2)}$	$\tilde{V}^{HF}_{sf(2)}$	$\tilde{V}^{H}_{sf}$	$\tilde{V}^{F}_{sf}$	$\tilde{V}^{HF}_{sf}$
I	π	—	1.568	1.568	—	-1.306	-1.306	—	0.262	0.262
	ρ	—	0.006	0.006	—	-0.005	-0.005	—	0.001	0.001
	ω	0.039	0.018	0.057	-0.156	-0.017	-0.173	-0.117	0.001	-0.116
	total	0.039	1.592	1.631	-0.156	-1.328	-1.484	-0.117	0.264	0.147
II	π	—	0.562	0.562	—	-0.468	-0.468	—	0.094	0.094
	ρ	—	0.004	0.004	—	-0.0035	-0.0035	—	0.0005	0.0005
	ω	0.071	0.033	0.104	-0.285	-0.030	-0.315	-0.214	0.003	-0.211
	total	0.071	0.599	0.670	-0.285	-0.502	-0.787	-0.214	0.097	-0.117
III	π	—	0.153	0.153	—	-0.128	-0.128	—	0.025	0.025
	ρ	—	0.003	0.003	—	-0.0026	-0.0026	—	0.0004	0.0004
	ω	0.055	0.025	0.080	-0.221	-0.023	-0.244	-0.166	0.002	-0.164
	total	0.055	0.181	0.236	-0.221	-0.154	-0.375	-0.166	0.027	-0.139
IV	π	—	0.068	0.068	—	-0.057	-0.057	—	0.011	0.011
	ρ	—	0.016	0.016	—	-0.014	-0.014	—	0.002	0.002
	ω	0.035	0.016	0.051	-0.142	-0.015	-0.157	-0.107	0.001	-0.106
	total	0.035	0.100	0.135	-0.142	-0.086	-0.228	-0.107	0.014	-0.093
DZ	π	—	0.443	0.443	—	-0.369	-0.369	—	0.074	0.074
	ρ	—	-0.011	-0.011	—	0.010	0.010	—	-0.001	-0.001
	ω	0.078	0.036	0.114	-0.313	-0.033	-0.346	-0.235	0.003	-0.232
	total	0.078	0.468	0.546	-0.313	-0.392	-0.705	-0.235	0.076	-0.159

(all the values - in eV)

DZ - formerly calculated magnitudes of surface terms for the set of Dubovik and Zenkin, for comparison.

1) It is well seen that the main regularities for surface terms, ascertained previously for the case of DZ, still hold for all the new sets I–IV:

a) in the separate parts $V_{sf(1)}^{HF}$, $V_{sf(2)}^{HF}$, $\tilde{V}_{sf(1)}^{HF}$, $\tilde{V}_{sf(2)}^{HF}$ → considerable enhancement of the Hartree components by the Fock ones, having the same sign;

b) mutually opposite signs of respective contributions $_{(1)}$ and $_{(2)}$, and the explicit tendency to the mutual compensation of Fock parts $_{(1)}$, $_{(2)}$; ⇒ ⇒ small values of total Fock terms V_{sf}^{F}, $\tilde{V}_{sf}^{F}$ and relatively small magnitudes of total surface terms V_{sf}^{HF}, $\tilde{V}_{sf}^{HF}$;

c) For the isoscalar term V_{sf}^{HF} → also strong prevalence of the total Hartree components over the total Fock ones (V_{sf}^{F}), having the opposite sign, for all the new sets as well as for DZ ⇒ essential predominance of ω-meson contribution in V_{sf}^{HF} ⇒ noticeable enhancement of V_{sf}^{HF} for sets with large values of $h_{\omega}^{(0)}$ (II, IV).

2) For the isovector term $\tilde{V}_{sf}^{HF}$ → prevalence of total Hartree components and the ω-meson contributions is observed for all the sets except I, where, due to the large $h_{\pi}^{(1)} = 4.6 \cdot 10^{-7}$ and small $h_{\omega}^{(1)} = -1.1 \cdot 10^{-7}$, the situation changes and the Fock part, determined nearly exclusively by the π-meson exchange, considerably dominates over the Hartree part. (For the set I, besides, $\tilde{V}_{sf}^{HF} > 0$ (contrary to other sets), just on account of the large repulsive total π-meson contribution).

Characteristic radial distributions of the main and surface terms.

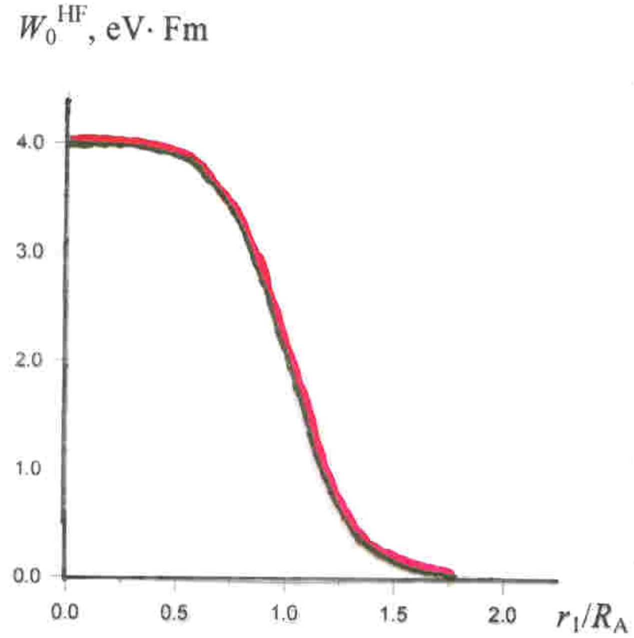

Fig.1. The total zero-order isoscalar component $W_0^{HF}(r_1)$ in the main term of the weak single-nucleon HF-potential for ^{40}Ca (set DZ)

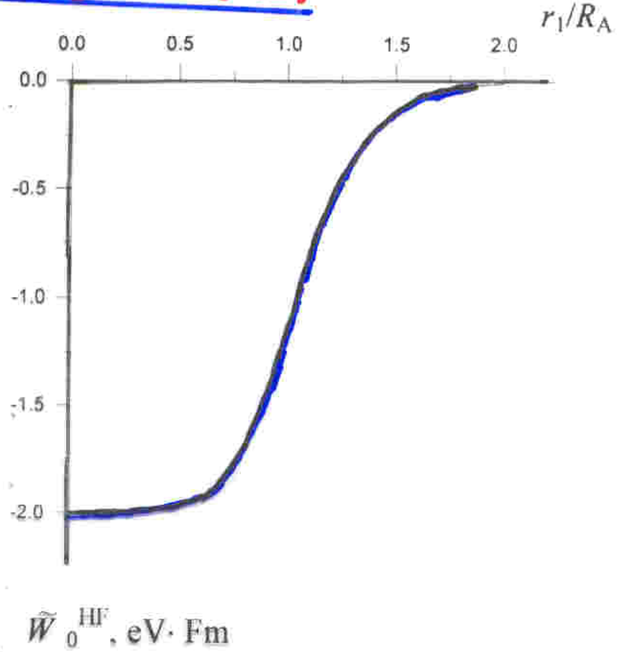

Fig.2. The total zero-order isovector component $\widetilde{W}_0^{HF}(r_1)$ in the main term of the weak single-nucleon HF-potential for ^{40}Ca (set DZ)

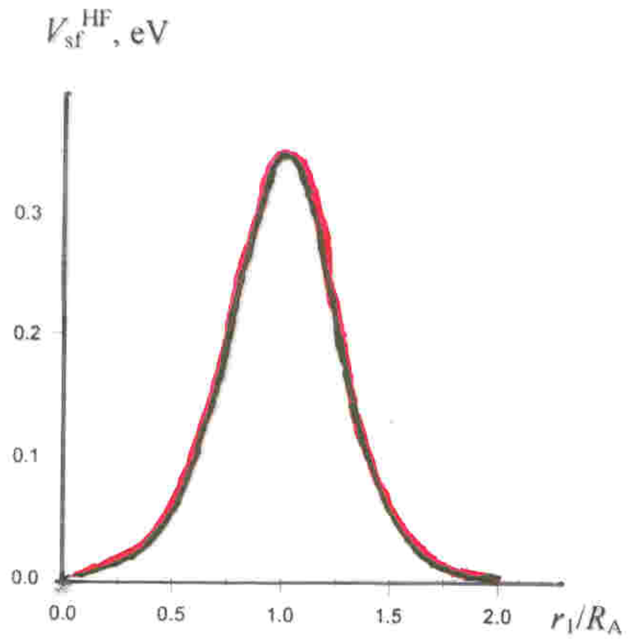

Fig.3. The total isoscalar surface term $V_{sf}^{HF}(r_1)$ in the weak single-nucleon HF-potential for ^{40}Ca (set DZ)

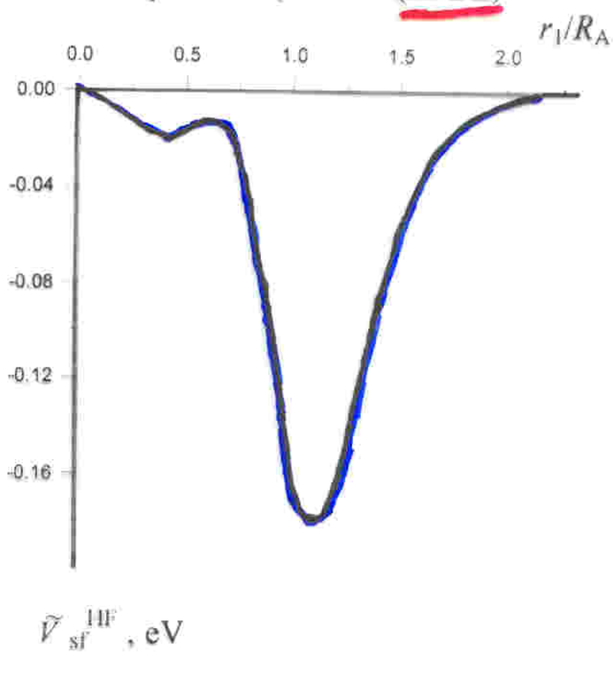

Fig.4. The total isovector surface term $\widetilde{V}_{sf}^{HF}(r_1)$ in the weak single-nucleon HF-potential for ^{40}Ca (set DZ)

For all the other sets I, II, III, IV the general character of radial dependences of respective components in V_W^{HF} is similar.

4 Comparison with weak phenomenological nucleon-nucleus potentials

$$V_w^{ph}(1) = W^{ph}(\tilde{1})(\vec{\sigma}_1 \hat{\vec{k}}_1) + i(\vec{\sigma}_1 \vec{e}_{r_1}) V_{sf}^{ph}(\tilde{1});$$

$$W^{ph}(\tilde{1}) = \frac{\pi\hbar^4}{2M_N^3 c^2}\Big((X_N^n + X_N^p) + \tau_{1z}(X_N^n - X_N^p)\Big)\rho(r_1),$$

$$V_{sf}^{ph}(\tilde{1}) = -W^{ph}(\tilde{1})\frac{d\rho(r_1)}{dr_1}\left(\rho(r_1)\right)^{-1}$$

($N=Z$; $\rho = 2\rho_n = 2\rho_p$; $\tau_{1z} = \begin{cases} +1, n \\ -1, p \end{cases}$; X_N^n, X_N^p – weak nucleon-nucleus constants)

Recent experimental values for X_N^n, X_N^p [B. Desplanques, Phys. Reports, 297, 1 (1998)]

$X_N^p \approx 3.4 \cdot 10^{-6}$; $X_N^n = (2.0 \div 4.2)\cdot 10^{-6} \Longrightarrow$

1) for $r_1 = 0$: $W^{ph} = \frac{\pi\hbar^4}{2M_N^3 c^2}(X_N^n + X_N^p)\rho_0 = (2.64 \div 3.72)\, eV \cdot Fm$

$\tilde{W}^{ph} = \frac{\pi\hbar^4}{2M_N^3 c^2}(X_N^n - X_N^p)\rho_0 = (-0.685 \div +0.39)\, eV \cdot Fm$

2) for $r_1 = R_A$: $V_{sf}^{ph}(R_A) = \frac{W^{ph}}{4a_0} = (1.22 \div 1.72)\, eV$;

$\tilde{V}_{sf}^{ph}(R_A) = \frac{\tilde{W}^{ph}}{4a_0} = (-0.32 \div +0.18)\, eV.$

(at $\rho_0 = 0.17\, Fm^{-3}$, $a_0 = 0.54\, Fm$)

	I	II	III	IV	DZ
$W^{HF}(E=0)$	4.079	3.631	4.477	2.594	3.543
$\tilde{W}^{HF}(E=0)$	-2.468	-1.265	-0.583	-0.385	-1.087
V_{sf}^{HF}	0.117	0.528	0.323	0.624	0.349
$\tilde{V}_{sf}^{HF}$	0.147	-0.117	-0.139	-0.093	-0.159

Final results for the main and surface terms of the weak single-nucleon HF-potential (^{40}Ca);
$W^{HF}(E=0)$, $\tilde{W}^{HF}(E=0)$ – in $eV \cdot Fm$ $(r_1=0)$
V_{sf}^{HF}, $\tilde{V}_{sf}^{HF}$ – in eV $(r_1=R_A)$.

So, we see that:

1) The isoscalar values $W^{HF}(E=0) \rightarrow$ good accordance with the phenomenological range of W^{ph} for the sets II, IV, DZ. Meantime, for the sets I, III with large values of $|h_\rho^0|$ ($\sim 1.1 \cdot 10^{-6}$) $\rightarrow W^{HF}(E=0)$ exceeds (by 10÷20%) the upper boundary of W^{ph}. (The best agreement of $W^{HF}(E=0)$ and W^{ph} may be expected under $|h_\rho^{(0)} + h_\omega^{(0)}| \sim (1.0 \div 1.3) \cdot 10^{-6}$)

2) The best accordance of the isovector values $\widetilde{W}^{HF}(E=0)$ with $\widetilde{W}^{ph} \rightarrow$ for the sets III, IV with small magnitudes of $h_\pi^{(1)}$ ($< 0.5 \cdot 10^{-7}$), and the greatest discrepancy $\rightarrow$ for set I with the largest $h_\pi^{(1)} = 4.6 \cdot 10^{-7}$.

3) The magnitudes of isoscalar surface terms $V_{sf}^{HF}(R_A) \rightarrow$ essentially smaller than the phenomenological values $V_{sf}^{ph}(R_A)$ for all sets I–IV and DZ. Some enhancement of $V_{sf}^{HF}(R_A) \rightarrow$ observed for sets II, IV with larger $|h_\omega^{(0)}|$ ($\sim 6 \cdot 10^{-7}$) (Satisfactory agreement of $V_{sf}^{HF}(R_A)$ and $V_{sf}^{ph}(R_A)$ could be achieved only at $|h_\omega^{(0)}| \gtrsim 1.2 \cdot 10^{-6}$)

4) The magnitudes of isovector surface terms $\widetilde{V}_{sf}^{HF}(R_A) \rightarrow$ in good accordance with $\widetilde{V}_{sf}^{ph}(R_A)$ for all sets I–IV and DZ

5 Summary

1. The framework of generalized Fermi-liquid theory is applied to the case of weak P-odd NN-interaction and the weak single-nucleon Hartree-Fock potential is constructed. Explicit expressions for various constituents of V_W^{HF}, including the contributions of π-, ρ- and ω-meson exchange, are derived.

2. Calculations of V_W^{HF} with 5 mutually different sets of weak meson-nucleon constants have shown that:

   a) different components of V_W^{HF} are sensitive to the values of different weak constants (e.g. isoscalar part of main term – to $h_\rho^{(0)}$ and $h_\omega^{(0)}$, isovector part of main term – to $h_\pi^{(1)}$, isoscalar surface term – to $h_\omega^{(0)}$);

   b) many basic regularities for V_W^{HF} survive in all the cases, though the respective values of weak constants in the sets may be strongly different from each other.

3. Calculations of V_W^{HF} allow one to test the sets of weak constants, by comparing the results with values of weak phenomenological nucleon-nucleus potentials