Indication of a reduced chiral order parameter from the 1s π^- state in ^{205}Pb

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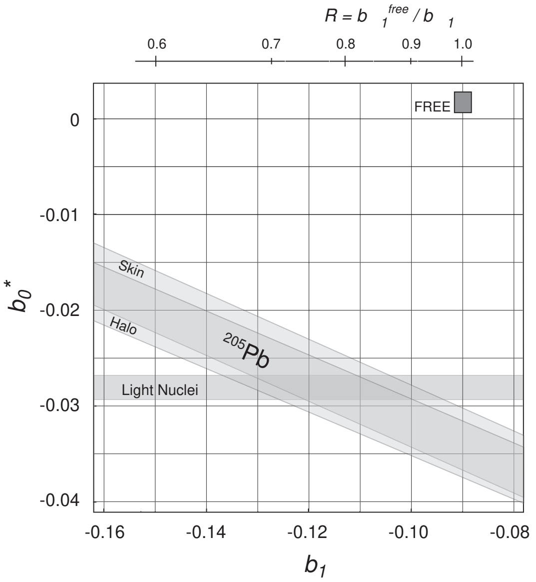
The isovector potential parameter (b_1) of the s-wave pion-nucleus interaction was deduced in an unambiguous way to be $b_1 = -0.116^{+0.015}_{-0.017}\ m_\pi^{-1}$ by using the binding energy and width of the recently observed deeply bound 1s π^- state in ^{205}Pb [1] combined with the known 1s states of light pionic atoms.



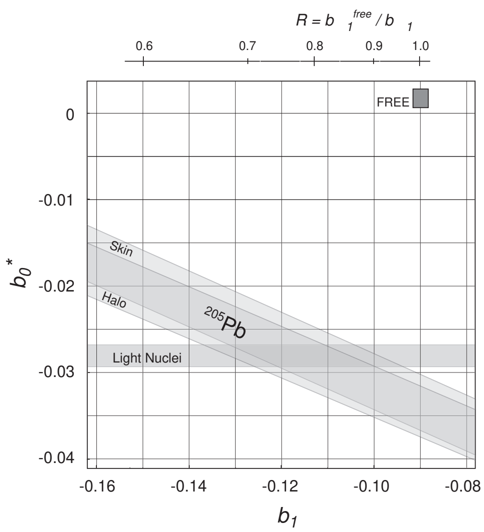
The figure presents the obtained isoscalar ($b_0^* \equiv b_0 + 0.215\,\mathrm{Re}B_0\, m_\pi^3$) and the isovector ($b_1$) parameters. The 1s states of light symmetric pionic atoms give a shaded horizontal band. The $b_0^* - b_1$ constraints from ^{205}Pb in the two cases of "halo type" and "skin type" neutron distributions are shown by other shaded bands with 1σ error lines. The scale for the reduction of the chiral order parameter $R = b_1^{\mathrm{free}}/b_1 \approx f_\pi^{*2}/f_\pi^2$ (f_π is the pion decay constant) [2] is indicated in the upper part. The enhanced isovector strength ($|b_1|$) over the free-πN value infers that the chiral order parameter is reduced by a factor of $R = 0.78\ ^{+0.13}_{-0.09}$ in the nuclear medium of ^{205}Pb where the bound π^- is located (the effective density ~ 0.59 times the normal nuclear density). This is in good agreement with Weise's prediction ($R \sim 0.82$ for this π^- bound state) [3].

References

[1] H. Geissel *et al.*, Phys. Rev. Let. **18** (2002) 122301.

[2] P. Kienle and T. Yamazaki, Phys. Lett. **B 514** (2001) 1.

[3] W. Weise, Acta Physica Polonica **31** (2000) 2715.



R = b 1 free / b 1
0.6
0.7
0.8
0.9
1.0
FREE
0
-0.01
-0.02
-0.03
-0.04
b0 *
Skin
Halo
205Pb
Light Nuclei
-0.16
-0.14
-0.12
-0.10
-0.08
b1