Chiral Dynamics of Deeply Bound Pionic Atoms

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We calculate shifts and widths of 1s and 2p states of pions bound to heavy nuclei, using an optical potential with its S-wave interaction part based on chiral symmetry. This potential is constructed systematically in two-loop approximation of chiral perturbation theory [1]. A proper teatment of the explicit energy dependence of this potential in conjunction with gauge invariance turns out to be very important.
Results are reported for deeply bound pionic states in ^{207}Pb and ^{205}Pb in comparison with the very accurate GSI data [2]. The notorious "missing repulsion" in the pion-nuclear S-wave interaction is well accounted for. Further studies are performed for several Sn isotopes. The connection with possible in-medium changes of the pion decay constant, as order parameter of spontaneously broken chiral symmetry, will be discussed.

References

[1] N. Kaiser and W. Weise, Phys. Lett. B 512 (2001) 283.
[2] E. Kolomeitsev, N.Kaiser and W. Weise, in preparation.