DYNAMICS OF DEEPLY BOUND $\bar{K}$ NUCLEAR STATES

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We explore *dynamical* effects for $\bar{K}$ deeply bound nuclear states with binding energy in the range of $B_{\bar{K}} \sim 100 - 200$ MeV, corresponding to recent experimental reports claiming evidence for such states in light nuclei [1-3]. Our main objective is to place lower limits on the width resulting from the $\bar{K}$ absorption in the nuclear medium. The theoretical framework adopted here is the RMF model for a system of nucleons and one $\bar{K}$ meson interacting through the exchange of scalar (σ) and vector (ω) meson fields which are treated in the relativistic mean-field approximation [4]. This dynamical calculation is made self consistent by successively allowing the $\bar{K}$ to polarize the nucleons, and the polarized nucleus to enhance the $\bar{K}$-nuclear interaction. $\bar{K}$ absorption modes are included within a $t\rho$ optical-model approach, where the density ρ plays a dynamical role, and the constant t which is constrained near threshold by K^--atom data follows the kinematical phase-space reduction for a deeply bound $\bar{K}$.

Varying the strength of $\bar{K}$ - nuclear couplings, we cover a wide range of binding energies in order to evaluate widths of possible strongly bound $\bar{K}$ nuclear states in ^{12}C, ^{16}O, ^{40}Ca, and ^{208}Pb [5]. Furthermore, in order to study effects of the nuclear polarization, we calculate rms radii, densities and single particle energies. Substantial polarization of the core nucleus is found in light nuclei for deeply bound $\bar{K}$ nuclear states, with central nuclear densities about twice higher than for the corresponding nuclei without the $\bar{K}$ meson. A lower limit $\Gamma_{\bar{K}} = 50 \pm 10$ MeV is placed on the width expected for binding energy in the range of $B_{\bar{K}} \sim 100 - 200$ MeV. The widths are mostly determined by phase-space suppression on top of the increase provided by the compressed nuclear density.

We discuss the results of the FINUDA experiment at DAΦNE [3] which presented evidence for deeply bound K^-pp states in Li and in ^{12}C, without resolving the data for different targets. For the interpretation in terms of $\bar{K}$ nuclear states, the binding energies as well as the widths calculated for Li are significantly different than those calculated for C. It is therefore important to resolve experimentally the A dependence of the observed $K^-pp \rightarrow \Lambda p$ FINUDA signal, in order to decide between the two alternative interpretations.

[1] T. Suzuki *et al.*, Phys. Lett. B **597** (2004) 263; and in Nucl. Phys. A **754** (2005) 375c.
[2] T. Kishimoto *et al.*, Nucl. Phys. A **754** (2005) 383c.
[3] M. Agnello *et al.*, Phys. Rev. Lett. **94** (2005) 212303.
[4] J. Mareš, E. Friedman, A. Gal, Phys. Lett. B **606** (2005) 295.
[5] J. Mareš, E. Friedman, A. Gal, arXiv: nucl-th/0601009, Nucl. Phys. A (in press).

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