# Level crossing of particle-hole and mesonic modes in eta nuclei

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We study eta meson properties in the infinite nuclear matter and in atomic nuclei with an emphasis on effects of the eta coupling to N*(1535)--nucleon-hole modes. The N*(1535) resonance, which dominates the low-energy eta-nucleon scattering, can be seen as a chiral partner of the nucleon. The change of the chiral mass gap between the N* and the nucleon in a nuclear medium has an impact on the properties of the eta-nucleus system. Typically, calculations done in previous works operated with energy-independent optical potentials. In the case when N*-N gap becomes close to or smaller than the eta mass it is not a reliable approximation anymore, and the energy dependence must be taken into account explicitly. The eta meson quantum numbers can be carried now not only by the eta-particle modes but also by the N*--nucleon-hole modes. In the present paper we study the propagation of these modes in nuclear matter and finite nuclei. We discuss a possibility of the formation of an “eta nucleus” by N*-nucleon-hole modes. If the N*-nucleon mass gap decreases with a density increase (chiral symmetry restoration) the calculations show the existence of the resonance state at the energy about 60 MeV and two bound eta-nucleus states with the binding energies about 80 MeV. These states can have strong effect on predicted cross sections of the photoproduction of protons on the carbon 12 associated with the eta-meson production.