Exotic neutron-rich nuclei in a three-body model

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Abstract. We present results for spatial distributions of weakly-bound three-body systems, derived from a universal scaling function that depends on the mass ratio of the particles, as well as on the nature of the subsystems.

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The approach to obtain the mean-square distances between particles in a weakly-bound three-body system [1, 2] considers a universal scaling function that depends on the mass ratio of the neutron and the core, as well as on the nature of the subsystems, bound or virtual. In the model, we have a minimal number of physical inputs, directly related to observables. As considered in Ref. [1], for halo-nuclei systems consisting of a core with two halo neutrons, for the low-energy observables it was used the neutron-neutron and neutron-core s-wave scattering lengths (or the corresponding virtual or bound energies).

A generic weakly three-body system $\alpha\alpha\beta$ can be described according to the two-body subsystems properties, as discussed in Ref. [1]. We have four possible configurations for such a system: *Borromean* configuration, when all the two-body subsystems are unbound; *Tango* configuration, when we have two unbound and one bound two-body subsystems; *Samba* configuration, when just one two-body subsystems is unbound; and *All-bound* configuration, when there is no unbound subsystems. To examine such weakly bound systems, the corresponding Faddeev formalism is given in some detail in another contribution to this proceedings [3], where is also given some results for the size of a few halo-nuclei systems.

In the present contribution we resume in Fig.1 our results for the mean-square distances of generic weakly-bound three-body systems $\alpha\alpha\beta$ where two particles are identical. In Figure 1, we have the root-mean-square (rms) distances between the particles in units of the inverse of the three-body binding energy E_3, plotted as functions of $K_{\alpha\beta}/|K_{\alpha\alpha}|$ and $K_{\alpha\alpha}/|K_{\alpha\beta}|$, where $K_{\alpha\gamma} \equiv \pm\sqrt{E_{\alpha\gamma}/E_3}$ $(\gamma = \alpha, \beta)$ and $E_{\alpha\gamma}$ is the energy of the $\alpha\gamma$ subsystem, with $+$ standing for bound and $-$ for unbound (virtual). Our units are such that $\hbar = 1$ and $m_\alpha = 1$. As evidenced by the results, where it was fixed E_3, the size of the three-body systems are such that the smallest one is the one where all the two-body subsystems are unbound (Borromean).

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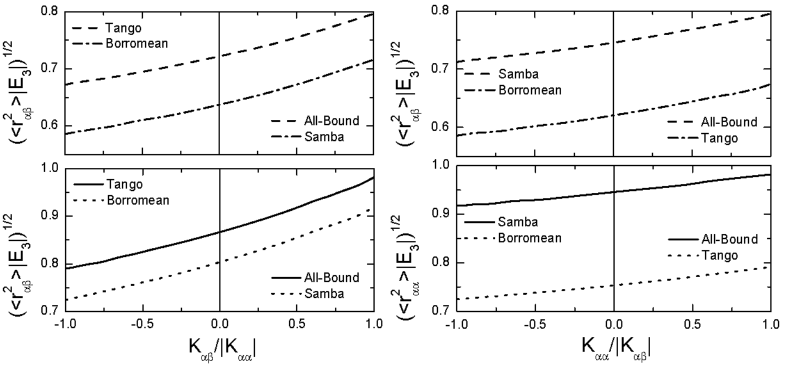

FIGURE 1. Dimensionless root-mean-square (rms) distances between the particles $\alpha\alpha$ and $\alpha\beta$, in units of the inverse of the three-body binding energy E_3, given as functions of $K_{\alpha\gamma} \equiv \pm\sqrt{E_{\alpha\gamma}/E_3}$ ($\gamma = \alpha, \beta$), as explained in the text. In all the plots the mass ratio is such that $m_\beta/m_\alpha = 200$. In the left hand side we have $E_{\alpha\alpha}/E_3 = 0.1$; and, in the right hand side, $E_{\alpha\beta}/E_3 = 0.1$. The behavior or the results follows the same trend for other mass ratios and two-body energy parameters.

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