Three-component mixtures of several fermions in one-dimensional harmonic trap

Marek Teske and Tomasz Sowinski

Institute of Physics, Polish Academy of Sciences

In this work, we study the many-body ground-state properties of three-component mixture of few fermions confined in one-dimensional harmonic trap and interacting with zero-range forces described with the Hamiltonian:

$$\hat{\mathscr{H}} = \sum_{\sigma} \int \mathrm{d}x\, \hat{\Psi}^{\dagger}_{\sigma}(x) \left[-\frac{1}{2}\frac{\mathrm{d}^2}{\mathrm{d}x^2} + \frac{1}{2}x^2 \right] \hat{\Psi}_{\sigma}(x) + \sum_{\sigma \neq \sigma'} g_{\sigma\sigma'} \int \mathrm{d}x\, \hat{n}_{\sigma}(x) \hat{n}_{\sigma'}(x).$$

Starting with a simple system of two-component mixture of four repulsively interacting particles, we explore impact of interactions with additional particle from the third component. We find that for any two-component repulsion g_{AB}, along with increasing interaction with third component $g = g_{AC} = g_{BC}$, the system undergoes structural transition in spatial ordering of the components. This transition is clearly visible in the single-particle density profiles $n_{\sigma} = \langle \mathtt{G} | \hat{n}_{\sigma} | \mathtt{G} \rangle$ as well as in the inter-component two-particle correlations $\mathscr{G}_{AB}(x, x') = \langle \mathtt{G} | \hat{n}_A(x) \hat{n}_B(x') | \mathtt{G} \rangle - \langle \mathtt{G} | \hat{n}_A(x) | \mathtt{G} \rangle \langle \mathtt{G} | \hat{n}_B(x') | \mathtt{G} \rangle$.