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Strong correlation effects in a two-dimensional Bose gas with quartic dispersion JURAJ RADIC, STEFAN NATU, VICTOR GALITSKI, University of Maryland, College Park — We consider a two-dimensional Bose gas at zero temperature with an underlying quartic single-particle dispersion in one spatial direction. This type of band structure can be realized using the NIST scheme of spin-orbit coupling, in the regime where the lower band dispersion has the form $\varepsilon_{\mathbf{k}} \sim k_x^4/4 + k_y^2 + \ldots$. We numerically compare the ground state energies of the mean-field Bose-Einstein condensate (BEC) and various trial wave-functions, where bosons avoid each other at short distances. We discover that, at low densities, several types of strongly correlated states have an energy per particle (ϵ), which scales with density (n) as $\epsilon \sim n^{4/3}$, in contrast to $\epsilon \sim n$ for the weakly interacting Bose gas. These competing states include a Wigner crystal, quasi-condensates described in terms of properly symmetrized fermionic states, and variational wave-functions of Jastrow type, where the latter has the lowest energy and describes a strongly-correlated condensate. Our results show that even for weakly-interacting bosons in higher dimensions, one can explore the crossover from a weakly-coupled BEC to a strongly-correlated condensate by simply tuning the single particle dispersion or density.

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