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Recent developments in auxiliary-field quantum Monte Carlo methods for cold atoms[1] HAO SHI, PETER ROSENBERG, ETTORE VITALI, SIMONE CHIESA, SHIWEI ZHANG, College of William and Mary — Exact calculations are performed on the two-dimensional strongly interacting, unpolarized, uniform Fermi gas with a zero-range attractive interaction. We describe recent advances in auxiliary-field quantum Monte Carlo techniques, which eliminate an infinite variance problem in the standard algorithm, and improve both acceptance ratio and efficiency. The new methods enable calculations on large enough lattices to reliably compute ground-state properties in the thermodynamic limit. An equation of state is obtained, with a parametrization provided, which can serve as a benchmark and allow accurate comparisons with experiments. The pressure, contact parameter, condensate fraction, and pairing gap will be presented. The same methods are also applied to obtain exact results on the two-dimensional strongly interacting Fermi gas in the presence of Rashba spin-orbit (SOC), providing insights on the interplay between pairing and SOC.

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