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Bose-Einstein condensation with attractive interactions ASAAD SAKHEL, JONATHAN DUBOIS, HENRY GLYDE, University of Delaware — We investigate 20 Bosons in a tight harmonic trap using quantum Monte Carlo methods. The Bosons interact via a pair potential that has a repulsive hard core plus an attractive square well leading to a negative scattering length. The total energy, Boson distribution in the trap, condensate fraction, condensate distribution in the trap and other properties are evaluated as a function of the attractive well depth (scattering length). In the weak attraction (dilute) limit, the Monte Carlo energies agree well with those calculated using the Gross-Pitaevskii (GP) equation. We also find a sharp increase in density in the regime where the GP equation predicts collapse. At the GP "collapse" point, we find a gas to liquid transition to a liquid density and energy that saturates to fixed values as the scattering length is increased. The liquid density depends on the HC diameter and the Range of potential. At the liquid densities, the scattering length is no longer a good representation of the potential. The condensate fraction depends chiefly on the hard core part of the potential. There can be substantial depletion of the condensate (e.g. 50 percent) and its value is qualitatively predicted by the Bogoliubov expression if the hard core diameter is used (rather than the scattering length).

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