

Van der Waals equation of state for hard-sphere system: A new twist to the old story

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For the system of hard-sphere particles the van der Waals equation of state is generalized to include the dependence of the excluded volume parameter on density. Analytical approximations are obtained for the parameter and shown to improve the accuracy of the equation. The results are tested against Monte Carlo simulations. Excluded volume is seen to drop by a factor of 2 over the density range where the system is still in the fluid state. Partial contributions of two- and three-sphere intersections to the excluded volume are analyzed. Implications of the obtained results for systems with attractive interactions and systems interacting via continuous potentials are discussed.