Dual Critical Points and Related Phenomena in Simple Fluids Calculated in a New Approximation

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Some single component fluids are known to have coexisting low-density and high-density fluid phases with two, separate, gas-liquid and liquid-liquid critical points. The possibility exists that this would also be the case for water if it could be prevented from freezing far enough below its normal ice point. Pressure, density, temperature behavior that is reasonably close to that found for water from well below its normal ice point to above its gas-liquid critical point over a wide range of densities has been found in earlier "global" renormalization group calculations applied to spherical molecules interacting with hard cores, soft repulsive shoulders, and attractive square wells [see J. A. White and K. P. Tewari "Dual Critical Points . . " Int. J. Thermophys. 25 (2004)1005 and J. A. White "Multiple Critical Points . . ." Physica A 346 (2005) 347] using a global renormalization group theory which had earlier proved successful in making predictions near and to far from the gas-liquid critical point for simple Lennard-Jones and square-well fluids for which accurate simulation data were available. New calculations will be reported for shoulders and wells of height, depth, and widths similar to those considered previously for water, but now using Monte Carlo methods before applying renormalization corrections, in order to confirm the accuracy of the earlier water work and also to see if there still appears to be the possibility sometimes of a third critical point, as noted in the Physica A paper cited above.