

Effects of Three-Body and Bonding Interactions on Phase Separation in an Exactly Solvable Ternary or Binary Solution on the Honeycomb and Bethe Lattices

R.P. Lungu

Department of Physics, University of Bucharest, Bucharest-Magurele, Romania

D.A. Huckaby^{C, S}

*Department of Chemistry, Texas Christian University, Fort Worth, Texas, U.S.A.
d.huckaby@tcu.edu*

F.D. Buzatu

Department of Theoretical Physics, National Institute for Physics and Nuclear Engineering, Bucharest-Magurele, Romania

A microscopic statistical mechanical lattice model for a ternary solution is considered in which the bonds of a three-coordinate Bethe or honeycomb lattice are covered with rod-like molecules of types AA, BB, and AB. The binary solution limit containing only AA and BB molecules is also considered. A triangle of neighboring molecular ends experiences three-body interactions, and an A-type molecular end can bond to neighboring A-type and B-type molecular ends. The model on a three-coordinate lattice can be transformed to an Ising model on the same lattice with a magnetic field but with only pairwise interactions. The ferromagnetic phase transition in the Ising model corresponds to separation into AA-rich and BB-rich phases in the equivalent solution model. The resulting coexistence surfaces for the ternary solution and phase diagrams for the binary solution limit were calculated exactly. Depending on the relative strengths of the interactions, one of several possible types of two-phase coexistence diagrams (or surfaces) can result, including a diagram that contains an asymmetric low-temperature phase coexistence curve, either with or without an accompanying asymmetric closed loop, or a diagram that contains either one or two asymmetric closed loops. There is also the possibility that a coexistence curve and a closed loop or two closed loops in the diagram can coalesce at a double critical point.