Apparent Mean-Field Criticality of Liquid-Liquid Phase Transitions in Ionic Solutions

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It is now common knowledge that the critical properties of phase transitions of fluids and fluid mixtures agree with that of the 3d-Ising model. This statement is proved for phase transitions driven by short-range r^{-n} interactions ($n > 3.97$). It was suspected that the universal validity of the 3d-Ising model may not apply for phase transitions driven by long-range Coulomb forces. In support of this conjecture mean-field critical behavior has been reported repeatedly for the liquid-liquid phase transition in ionic solutions. However, later work did not state those work, but led to the conclusion that systems with phase transitions driven by Coulomb interactions also belong to the 3d-Ising universality class. In order to pinpoint the traps that led to false conclusions, we review the controversy work on Pitzer´s system, n-hexyl-triethylammonium + n-hexyl-triethylborate/biphenyl ether, on the ternary mixtures of 3-methylpyridine (3MP) /H_20/NaBr and report puzzling results on the solutions of the Room Temperature Ionic Liquid (RTIL) 3-hexyl-1-methyl imidazolium tetrafluoroborate in alcanols and tetra alkyl phosphonium halogenides in hydrocarbons.