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A Renormalized Theory of Composition Fluctuations in Polymer Mixtures

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Attempts to calculate corrections to Flory-Huggins theory using field theoretic methods have been plagued by an unwanted sensititivity to very short wavelength fluctuations, or to the value of an arbitrary cutoff length. This reflects the fact that the total free energy of a polymer mixture is dominated by effects of local fluid structure. Z.-G. Wang [1] has shown how the cutoff-dependence of a one-loop approximation for the free energy of a binary blend can be absorbed into an expression for the experimentally observed χ parameter, yielding a cutoff-independent renormalized theory of the contributions of mesoscopic fluctuations. We apply an analogous renormalization procedure to one-loop calculations of intramolecular and collective correlation functions at arbitrary wavenumbers in both homopolymer blends and copolymer melts, in which the dependence on local fluid structure is absorbed into the values of χ and of statistical segment lengths. We discuss predictions for homopolymer blends and diblock copolymer melts, and relationships to earlier work. [1] Z.-G. Wang, J. Chem. Phys. 117, 481 (2002).