The physics of entangled and untangled polymer solutions: from tube models to territorial ring polymers and chromosomes

Ralf Everaers

Laboratoire de Physique, École normale supérieure de Lyon

46, allée d'Italie, F-69364 Lyon Cedex 07, France

Lecture Description: Diffusing polymers can slide past each other, but their Brownian motion is subject to topological constraints, since the chain backbones cannot cross. In my lecture I will discuss consequences of this effect for Soft and Living Matter. In my first lecture, I will review the Rouse and the Edwards/de Gennes tube models of polymer dynamics and their explanation of how microscopic "entanglements" dominate the macroscopic viscoelastic behavior of polymer liquids. Furthermore, I will introduce the Kremer-Grest bead-spring model and computational techniques used for simulating these generic model systems. The lecture focuses on two questions: 1) how can computer simulations be used to explore the physics underlying the tube model and 2) how should we model / think about chromosome folding in interphase nuclei, where reptation times far exceed biologically relevant times scales. In my second lecture, I will discuss the Statistical Physics of non-concatenated (untangled) ring polymers, which crumple and segregate in the melt state and which provide quantitative, non-trivial models for the large scale structure of interphase chromosomes. Furthermore, I will present results from a recent collaboration with experimental colleagues, where we have studied chromosome folding in Drosophila in the course of development from the fertilized egg to the embryo.