MAR08-2007-004780

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Polymers in Confined Geometry

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Thanks to P. G. de Genne's famous "$n = 0$" theorem (relating the configuration of a polymer chain to a magnetic phase transition with an order parameter of $n = 0$ component), the swelling exponent ν ($R = N^{\nu}a$) was calculated in terms of space dimension d and fitted the qualitative Flory calculation. Using scaling laws, or the "blob" picture, it became possible to derive the conformation of a chain confined in a tube or a slit. The dynamics of confined polymers followed immediately. The new feature was the screening of the hydrodynamic interactions in confined geometry leading to Rouse-like behaviour. In a third step, de Gennes focused on the forced penetration of polymers (linear, branched, stars, neutral or charged) in narrow tubes, when they are submitted to a flow (or an electrical field for DNA). From all these calculations, the conclusion was that the threshold velocity (or field) corresponds to the penetration of the first blob. Afterwards, the friction force increases linearly with the penetrated length, whereas the confinement force remains constant. In the last few years, with his collaboration we studied the penetration of DNA in "soft" tubes. We predicted a transition from extended to globular DNA observed experimentally. We also showed that semi flexible polymer chains, like DNA, are ideal in 3d, but swollen effects are more pronounced in confined geometries. We will also discuss experiments inspired by his work on confined polymers, in the last thirty years.