Resummation of ε-expansion for co-polymer star exponents reveals the order of the phase transition in thermal denaturation of DNA

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In the mid-sixties of the last century Douglas Poland and Harold A. Sheraga suggested a theoretical model that describes the process of thermal denaturation of DNA in a manner analogous to phase transitions [1]. The model suggests that the order of the transition is identified by the value of a so-called loop exponent c. This is universal and can be expressed in terms of the exponents governing scaling properties of DNA strands. Their values, however, are not easily obtained and are usually identified through divergent (asymptotic at best) expansions. In this work we analyse applicability of resummed $\varepsilon = (4 - d)$-expansion for scaling exponents describing thermal denaturation of DNA in $d = 3$ dimensions. To this end, we used a fourth-order ε-expansion series for the co-polymer star exponents [2] and applied resummation techniques refined by the conformal mapping of a plane with a cut along the negative semiaxis onto a disc. The expressions take into account both properties of the solution and possible affects of self- and mutual interactions of single and double DNA strands. Subsequently, our results give evidnce of the fact that the effects studied significantly influence the strength of the first order transition. This becomes manifest in the changes shown by the scaling laws that govern the DNA loop and strand distribution.

References

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[2] V. Schulte-Frohlinde, Yu. Holovatch, C. von Ferber, and A. Blumen, Phys. Lett. A, **328**, 335 (2004)