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Denaturation of circular DNA through supercoil formation

Alkan Kabakcioglu*

Koc University, Physics Department, Istanbul-Turkey
* Electronic Address: `akabakcioglu@ku.edu.tr`

We generalize the Poland-Scheraga (PS) model to the case of a circular DNA, taking into account the twisting of the two strains around each other. The proposed construction preserves the total linking number of the system which is a topological invariant. Guided by the observations in recent single molecule experiments on DNA strands, we assume that the torsional stress induced by denaturation enforces formation of supercoils whose writhe absorb the linking number expelled by the loops. We find that the first-order melting transition observed in the PS model survives under certain conditions, whereas the second-order transition in the PS model for $1 < c < 2$ vanishes upon the introduction of linking number conservation. These results are in contrast with other treatments of DNA melting with twist where denaturation is accompanied by an increase in twist rather than writhe.

[1] A. Kabakcioglu, D. Mukamel, E. Orlandini, in preparation.