Properties of Topological Networks of Flexible Polygonal Chains

J. Arsuaga, Y. Diao, M. Klingbeil, V. Rodriguez

Preprint no. 2013-16

Abstract

Trypanosomatida parasites, such as trypanosoma and leishmania, are the cause of deadly diseases in many third world countries. The three dimensional structure of their mitochondrial DNA, known as kinetoplast DNA (kDNA), is unique since it is organized into several thousands of minicircles that are topologically linked. How and why the minicircles form such a network have remained unanswered questions. In our previous work we have presented a model of network formation that hypothesizes that the network is solely driven by the confinement of minicircles. Our model shows that upon confinement a percolating network forms. This network grows into a space filling network, called saturating network, upon further confinement of minicircles. Our model also shows, in agreement with experimental data, that the mean valence of the network (that is, the average number of minicircles topologically linked to any minicircle in the network) grows linearly with minicircle density. In our previous studies we disregarded DNA flexibility and used rigid minicircles to model DNA minicircles, here we address this limitation by allowing minicircles to be flexible. Our numerical results show that the topological characteristics that describe the growth and topology of the minicircle networks have similar values to those observed in the case of rigid minicircles suggesting that these properties are robust and therefore a potentially adequate description of the networks observed in trypanosomatid parasites.

Department of Mathematics, UNC Charlotte, Charlotte, NC 28223