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Physical descriptions of the bacterial nucleoid at large scales, and their biological implications

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Recent experimental and theoretical approaches have attempted to quantify the physical organization (compaction and geometry) of the bacterial chromosome with its complement of proteins (the nucleoid). The genomic DNA exists in a complex and dynamic protein-rich state, which is highly organised at various length scales. This has implications on modulating (when not enabling) the core biological processes of replication, transcription, segregation. We overview the progress in this area, driven in the last few years by new scientific ideas and new interdisciplinary experimental techniques, ranging from high space- and time-resolution microscopy to high-throughput genomics employing sequencing to map different aspects of the nucleoid-related interactome. The aim of this review is to present the wide spectrum of experimental and theoretical findings coherently, from a physics viewpoint. We also discuss some attempts of interpretation that unify different results, highlighting the role that statistical and soft condensed matter physics, and in particular classic and more modern tools from the theory of polymers, plays in describing this system of fundamental biological importance, and pointing to possible directions for future investigation.

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