IOP Publishing

Journal of Physics: Condensed Matter

J. Phys.: Condens. Matter **27** (2015) 060301 (2pp)

doi:10.1088/0953-8984/27/6/060301

Preface

The physics of chromatin

Guest Editors

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This special issue is devoted to the physics of chromatin, the complex of DNA and proteins that fills the nuclei of eukaryotic cells (eukaryotes include animals, plants and fungi). The structure of chromatin is hierarchical with length scales ranging from the subnanometer height of a base pair via the 10 nm sized nucleosomes (DNA wrapped protein cylinders) up to the micrometer sized nuclear compartment (that typically stores meters of DNA molecules). As a consequence, to learn about the structure and function of chromatin one needs to employ a vast range of experimental and theoretical methods. One only has to realize that 11 years ago it was still acceptable to write a review [1] with the same title as this special issue that dealt mainly with elastic beams ('DNA') and balls ('nucleosomes') to understand what tremendous progress, experimentally and theoretically, has taken place in the meantime. The contributions to this special issue reflect this.

This issue starts with base-pair sequence dependent nucleosome models to learn about microscopic details [2] or global nucleosome occupancies [3]. Conformational changes in nucleosomal DNA, either caused by thermal fluctuations [4, 5] or supercoiling [6], follow next. The interaction of proteins with DNA, a nucleosome or nucleosomal arrays is discussed in the next five contributions, ranging from non-specific DNA condensation [7] via DNA target search [8] and active remodeling of nucleosomes [9] to the binding of heterochromatin protein 1 to nucleosomal arrays [10, 11]. The structures beyond the nucleosome are still highly debated and that is why it is important to study the interaction of nucleosome core particles [12] and that between nucleosomes in nucleosomal arrays of various linker lengths [13, 14]. Allosteric regulation in chromatin fibers is proposed [15] and the polymorphic nature of the chromatin fiber is the subject of a topical review [16]. Moving higher in the hierarchy, two studies are devoted to diffusion inside the crowded nuclear environment [17, 18]. Finally, a wide range of approaches is applied to study chromatin organization on large scales [19–22].

Now, as our understanding of the different levels of chromatin has progressed so much, the future challenge will be to combine the different insights into a more coherent view of all the levels. It will be interesting to see how far this field will get within the next 11 years.

We thank the authors for their contributions, the unnamed referees for their constructive criticism and the publishing staff to make this special issue possible.

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