MODELING OF CHROMATIN DNA USING CIRCULAR INTENSITY DIFFERENTIAL SCATTERING

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To know about higher order structure of chromatin, the chromatin fibre has been modeled as helices and circular intensity differential scattering, m_{03} element of Mueller matrix, has been computed by varying different parameters of the helices.

Keywords: Chromatin, Mueller matrix

1. Introduction

Chromatin is a complex of DNA and proteins found in the cell nucleus [1]. It is highly dynamic and plays a primary role in DNA packaging and regulating nuclear processes. There have been extensive research to know about chromatin structure during the cell cycle and still it is a challenge to know the mechanisms by which chromatin structures are assembled and modified.

The widely used approaches to know about chromatin organization are based on optical microscopy super-resolution methods [2], and light scattering [3]. The investigation of chromatin DNA by super resolution methods requires development of fluorescent probes for specific labelling that impose a challenge. Therefore, to demonstrate the chromatin organization without the requirement of labelling, in our lab we have been working on one label free non-invasive microscopy approach that is based on polarization control of light in the scattering regime. When the polarized light interact with some sample, measuring the scattered light we can infer about the size, shape, birefringence, dichroism, molecular orientation of that sample. The 4x4 Mueller matrix [4] is the mathematical description that demonstrates all these polarization properties of sample such as dichroism, birefringence and scattering. The different elements of Mueller matrix demonstrate different polarization properties of the samples. The m_{03} element of Mueller matrix, known as circular intensity differential scattering (CIDS), has particularly been reported to describe chiral properties of the sample [5-7].

In this work we computed all 16-elements of Mueller matrix for different helical models of chromatin DNA using the discrete dipole approximation (DDA) [8,9]. The changes in Mueller matrix elements have been measured by varying different parameters of the helices, such as pitch, radius, number of turns and height of helices. Measuring these changes, we can observe the changes in chromatin fibre structure. We have investigated the structures using wavelength spectrum in the ultraviolet and visible range. Fig. 1a shows the DDA model of helices, discretized helices into polarizable point dipoles. The Mueller matrix elements computed using DDA have been shown in Fig. 1b. We calculated the CIDS signal, m_{03} element, under the orientation averaging of the helices. The CIDS is sensitive to the chirality of the sample as shown in Fig. 1b. The CIDS is a label-free method to monitor changes in conformation of the chiral structures.

Fig. 1a. DDA model of helices. r=0.25µm, height=5µm.

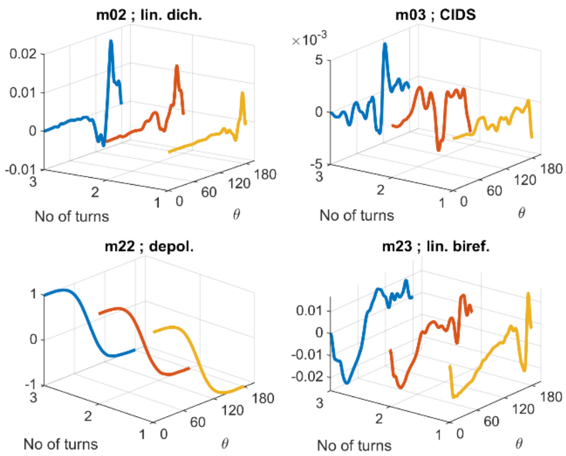

Fig. 1b. Mueller matrix elements. m=1.18, λ=0.5µm.

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