LOW-FREQUENCY VIBRATIONS OF DNA WITH COUNTERIONS IN CROSS-STRANDED POSITION

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Low-frequency vibrations of DNA with counterions between phosphate groups of different strands of the double helix are studied in the framework of a developed phenomenological model. The frequencies, amplitudes, and Raman intensities of DNA modes in the frequency interval from 10 to 200 cm^{-1} are calculated for the case of Mg^{2+} counterions at different positions with respect to the double helix strands (near or between phosphate groups). The calculations show that the counterions between phosphate groups influence the modes of H-bond stretching in the base pairs and the modes of backbone vibrations mostly. Using the calculated intensities and the frequencies of vibrations, the low-frequency Raman spectra of Mg-DNA are built. The obtained spectra allow us to distinguish the positions of counterions with respect to the phosphate groups of the DNA double helix.