

Four-photon laser spectroscopy of rotational lines in water: observation of protein/DNA selective interaction with H₂O para-isomer in aqueous solutions

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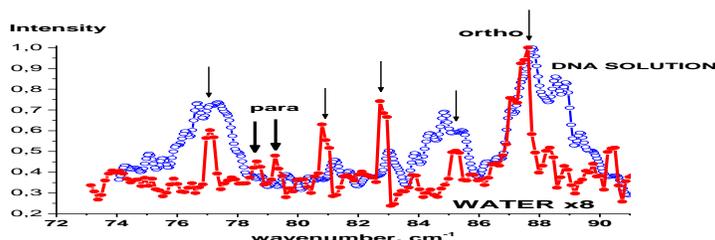
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The four-wave mixing (FWM) spectra have been recorded in the microwave range (0.1-100 cm⁻¹, 3GHz-3THz) for distilled water, aqueous solutions of DNA, α-chymotrypsin protein and single wall carbon nanotubes (SWNT) suspension. The method is based on mixing of two laser waves at frequencies ω_1 and ω_2 , whose difference $\pm(\omega_1 - \omega_2)$ is scanned in the microwave range (both, in positive and negative detuning value). The parameter to be measured is the depolarization of radiation at the frequency $\omega_s = \omega_1 - (\omega_1 - \omega_2)$, whose nonlinear source is given by:

$$P_i^{(3)} = 6\chi_{ijkl}^{(3)}(\omega_s; \omega_1; \omega_2; -\omega_1) E_j^{(1)} E_k^{(2)} E_l^{(1)*},$$

where $\chi^{(3)}$ is the cubic susceptibility of the medium, proportional to the correlation function of optical anisotropy fluctuations, and $E^{(1)}$ and $E^{(2)}$ are the amplitudes of the interacting fields and $I_s \propto |\chi^{(3)}|^2 I_1^2 I_2$ is the intensity of coherent signal.

The experiments shown that FWM^{1,2} signal of distilled water in the range 0.1-100 cm⁻¹ involves the known gas-like rotational spectrum of H₂O *ortho/para* spin-isomer molecules. It was established that in the biopolymer's (protein, DNA) aqueous solutions the *ortho* isomer rotational lines intensity increases by factor of ~10. In contrary, the *para* isomer's lines are suppressed considerably. Thus, the selective interaction of H₂O spin isomers with biopolymers was observed for the first time to our knowledge in aqueous solution. We suggest that the biological macromolecules are able to selective influence on the concentration of H₂O spin isomers at the nearest surrounding layers. Remarkably, the interaction DNA-H₂O efficiency in the interface layers is reducing substantially due to DNA denaturing at 95 °C for the 30 minutes. The Figure demonstrates the FWM spectra in the range 73-91 cm⁻¹ of DNA aqueous solution (concentration 15mg/ml, open circles) and *Milli-Q* water (multiply by factor of x8), full circles. The rotational resonances of *ortho*- and *para*- isomers are marked by thin and thick arrows, respectively.



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