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Laser interferometry of the hydrolytic changes in protein solutions: the refractive index and hydration shells

R. M. Sarimov[1] · **T. A. Matveyeva**[1] · **V. N. Binhi**[1,2]

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Supplementary Material

The algorithm for converting signals of the sensors A and B of the interferometer (Fig. 1 of the main article) into a change in the difference between the refractive indices of the solutions in the test and control cells is described below. The algorithm is illustrated by the example of a change in the water temperature in one of the cells, since there are accurate data connecting the refractive index of water and its temperature. The change in Δn of water, while one of the cells is heated, is used to calibrate the interferometer.

Before starting the measurements, one of the cells was cooled by approximately 1°C. Then, water in the cell was slowly heated to the room temperature due to the natural heat exchange with the surrounding medium.

Due to the change in Δn, the bands of the interference pattern shifted and the signals $a(t)$ and $b(t)$ of A and B sensors changed periodically. These signals were normalized using the PL photodiode signal that measured the intensity of the laser, Fig. 1. The figure shows that the interference pattern shifted by approximately 5π for 1200 s when heated by 0.4 °C.

The aperture and position of the sensors were chosen so that the phases of signals $a(t)$ and $b(t)$ differed by $\pi/2$. This made it possible to determine the phase $\varphi(t)$ of any of the signals by the formula

$$\varphi(t) = \arctan\left[\frac{a(t)}{b(t)}\right]$$

Ruslan M. Sarimov
E-mail: rusa@kapella.gpi.ru ·

[1] A. M. Prokhorov General Physics Institute of the Russian Academy of Sciences, 38 Vavilov St., Moscow 119991, Russian Federation

[2] M. V. Lomonosov Moscow State University, Faculty of Biology, Leninskie gory 1, bldg. 12, Moscow 119991, Russian Federation

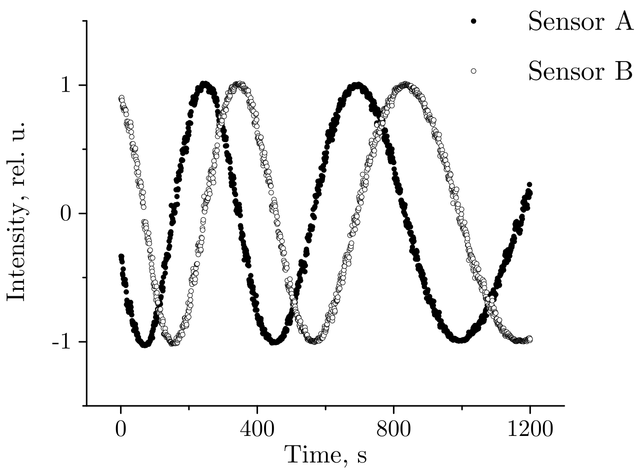

Fig. 1 Change of the signals of A and B sensors. Each point is the signal value averaged over 1 s interval, with a data acquisition frequency of 100 Hz.

The upper chart of Fig. 2 shows the variation of $\varphi(t)$ at slow heating of one of the cells. To convert $\varphi(t)$ to a change in the refractive index Δn, the data were "stitched" and multiplied by a coefficient that had been chosen so that the change in the refractive index of water in a given temperature range corresponded to known data, Fig. 2 below.

The real algorithm for converting $a(t)$ and $b(t)$ signals to $\Delta n(t)$ slightly differed from the above illustration in that the signal processing program automatically determined and took into account the difference in the magnitude of the signals that occurred due to the deviations from ideal geometry of the interference pattern.

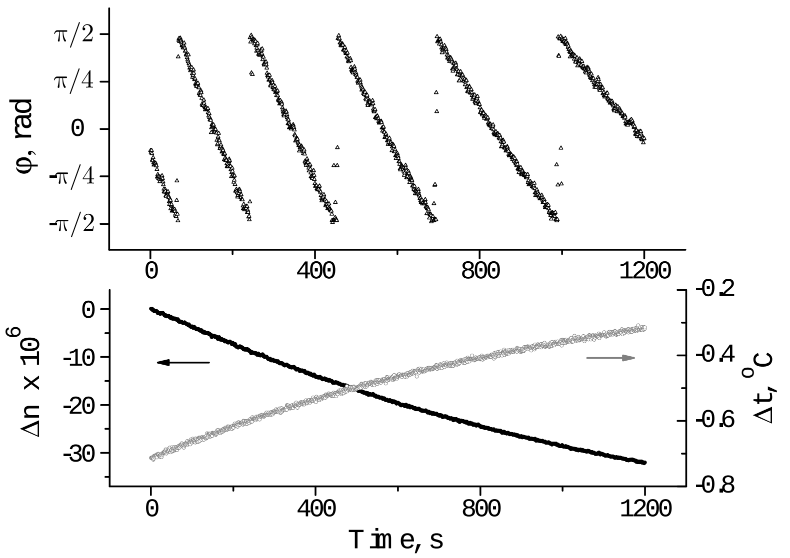

Fig. 2 The phase of the interference pattern (upper chart) and the difference in the refractive indices of water in the cells and in their temperatures (lower chart).