B R I E F   C O M M U N I C A T I O N S

INVESTIGATION OF THE TIME VARIATION OF TRANSMISSION SPECTRA OF AQUEOUS SOLUTIONS AND THEIR CORRELATION WITH SPACE-PHYSICS PHENOMENA

V. S. Tsaplin, Yu. I. Logachev,
and E. L. Kondrat'ev

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The need for performing the experiment described herein is justified. The correlation between the transmission spectrum of an aqueous solution at λ = 810 nm and the readings of the neutron monitor (correlation coefficient of 0.63) is found, which may serve as an indication of the relationship between phenomena occuring in the outer space and the structure of aqueous solutions.

During the past several decades a large volume of statistical data was accumulated in support of the relationship between the progress of a number of biological and physico-chemical processes and the cyclical or eruptive solar activity [1,2]. However, in spite of the existence of a number of assumptions on the possible mechanisms of such phenomena, and on the nature of the agent responsible for this interaction, no consistent and experimentally validated hypotheses are available. One of the assumptions put forward is on modifications of the structural properties of aqueous solutions due to natural fields. In fact, the role of water in the construction of biological systems is a well known factor, and in addition, the majority of physico-chemical systems exhibiting this relationship are aqueous systems.

At the same time, a number of studies are available [3-5] from which it follows that certain physico-chemical properties of water (more precisely, of dilute aqueous solutions of salts) actually become modified due to a static or variable magnetic field, which exceeds by several orders of magnitude the strength of the terrestial magnetic field. In particular, modification of the optical properties of aqueous solutions subjected to a magnetic field, has been reliably recorded. Modification of optical properties should be associated with modification of the structure of the medium which, evidently should be reflected in the kinetics of biochemical reactions and other physico-chemical processes.

It is logical to assume that natural fields also induce insignificant and long-period modifications of aqueous solutions. The insignificance of this effect also possibly explains the fact such modification could not be detected preveiously due to the short duration of spectrometer measurements, or that they were interpreted as errors. To check these assumptions, we performed an experiment, the purpose of which was long-term spectrometer measurements of the trans-

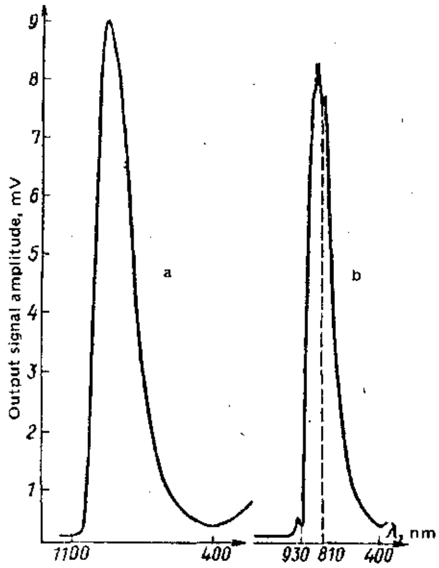

Fig. 1. Transmission spectrum of an empty tray (a) and a tray with water in it (b).

mission of an aqueous solution. We assembled a two-channel unit with the monochromator of the SF-4A spectrophotometer as its basis. The light flux from the source was subdivided into two beams, serving as the measuring and the reference channels. Each of the beams was alternately cut by a rotating shutter at a frequency of 120 Hz and, after a number of reflections, was fed to the input of the monochromator. Following the latter, the optical signals were transformed into electrical signals by an FEU-83 photomultiplier, and, after passing the measuring part of the channel (electronic switches and phases detectors) was recorded by two KSP-4 recorders. As a result, the signals of the measuring and reference channels were recorded simultaneously.

Tap water, which was let to settle for several days before the measurements, was poured into the measuring-channel tray (which was cylindrical, of quartz glass with fused-quartz light-beam input). No special measures were taken for purifying the water or for analyzing its chemical composition. The tray was fastened on a Teflon frame and was in no way screened. Water was poured through a stub with a sungly-fitting plug. The temperature inside the tray was measured through a horizontal capillary, through which a thermal resistance, connected to a temperature-measuring circuit, was placed. Spectra of the empty and filled trays over the 400 to 1100 nm range were taken during the time when preparations for the experiment were made (Fig. 1). It is seen from the figure that at $\lambda \simeq 810$ nm and $\lambda \simeq 930$ nm the spectrum of water has singularities, apparently associated with the nature of impurities, whereas the measurements at other spectral ranges are monotonic in nature. The measurements were performed at $\lambda \simeq 810$ nm, because the large magnitude of the light flux guaranteed sufficient accuracy and stability with better resolution. All the components of the test facility remained stationary during the measurements, and no readjustments were made.

Figure 2 shows the results of measurements performed on 2 to 4 November 1978. Figure 2a illustrates the nature of changes of the signal in the measuring (I_m), reference (I_r) and temperature channels; it is seen that the transmissivity of the medium changes perceptibly, as compared with virtual stability in the reference and temperature channels. The curve of ΔI in Fig. 2b was obtained by subtracting the readings of the reference channel from those of the measuring channel with subsequent smoothing over 12 points. The magnitudes of the rms errors for the different segments are shown in the figure. It is seen that changes in ΔI are 3% during the period of measurements, which is well within the sensitivity of the apparatus. The temperature variations (curve of ΔT) did not exceed 0.7°C, which in no way can induce changes of several percents in the scattering of light. In fact, the light-scattering capacity is so low that it does not change over the 20 to 60° temperature range [6]. Since the main purpose of the experiment was determining the relationship with space-physical factors, the value of ΔI was compared with the readings of the neutron monitor. (This monitor records neutrons produced by energetic space particles in the matter above the detector.) The monitor data have the advantage that they reflect a large number of processes

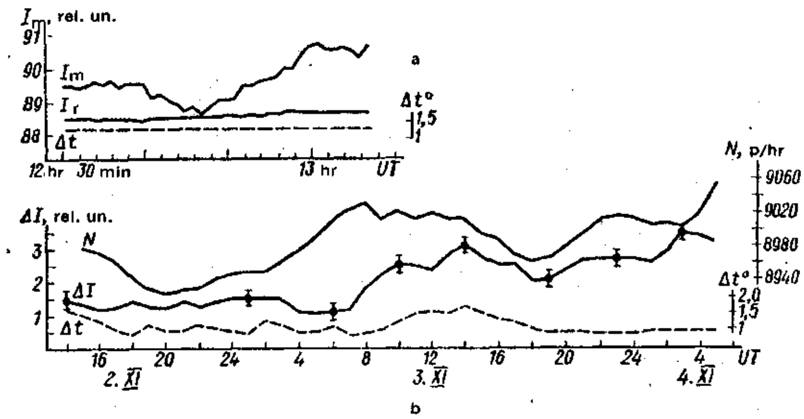

Fig. 2. Example of variations in transmission in the measuring and reference channels (a). Comparison of time variations of the difference signal and readings of the neutron monitor (b).

occuring in the outer space (variations in solar plasma fluxes, flareups, variations in magnetic fields, in space radiation fluxes) and variations in atmospheric parameters (pressure, temperature). The hourly mean smoothed readings of the Institute of Terrestial Magnetism, the Ionosphere and Radio Wave Propagation of the USSR Academy of Sciences neutron monitor (geomagnetic cutoff rigidity about 2.5 gilbert) are plotted in Fig. 2b, curve N. Smoothing was over three points. The coefficient of correlation between ΔI and N is equal to 0.63 with 0.99 confidence, which should be regarded as a significant quantity, with reference to the rather general nature of the comparison, and also to the fact that when the curves are shifted relative to one another by 1 to 3 hr, the correlation coefficient decreases to 0.5-0.3. Probably, a better relationship can be detected only with some space-physical factor taken in "pure form."

The above results should be treated as an indication of the existence of a relationship between the structure of aqueous solutions and processes occuring in the outer space or in the atmosphere. Hence the construction of any models of such an interaction and discussion on the nature of the agent responsible for this interaction appear premature. It is necessary to further improve the accuracy and stability of the measuring equipment, perform prolonged measurements at different wavelengths, and single out a factor of the outer-space medium which exhibits the tightest relationship with the observed effects.

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