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Water Spectra as a Method to Study Natural Waters

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Abstract. The method of water spectra for investigation of natural waters is discussed.

Water spectrum is defined as the distribution of contact angles of a sessile drop during the process of the drop evaporation. Water spectra are sensitive to physical influences and chemical ingredients. The sample-snow water- was collected from the National Park of Rila Mountain from the place the peak of Moussala. A graphic representation of the sample water spectrum is given.

1 Introduction

The paper discusses the method of measurement of water spectra and some of its applications. Water spectrum is defined as the distribution $f(\theta)$ of contact angles of a sessile drop during the process of the drop evaporation [1]. Water drops are investigated extensively in air and also in liquid crystals [2,3].

2 Material and Measurements

The material was collected from the National Park of Rila mountain from the place the peak of Moussala. The research material consists of snow water to be measured by the method of water spectra. The method of measurement consists of measuring the contact angle of a sample drop taken from the collected snow water sample. The drop is placed on a non-wettable substrate (hostaphan). For small drops with a weight about 10 mg its contact surface with air is of spherical form, shown on Figure 1. During the whole process of drop evaporation the contact angle is measured at fixed time intervals. The probability of measuring a given angle to lie inside an angle interval is plotted on Y-axis versus the angle intervals plotted on X-axis. The geometry of the water drop is shown in Figure 1.

By measurement of the drop's contact angle θ during the evaporation one gets the distribution $f(\theta)$ of θ. Using $f(\theta)$ one can change the argument

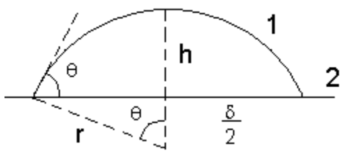

Figure 1: Geometry of evaporating drop 1 placed on the hydrophobic substrate 2 with contact angle θ, radius of its spherical surface r and diameter δ of the contact area with the substrate.

of the distribution from angle variable to energy variable by the formula:

$$f(E) = \frac{bf(\theta)}{\sqrt{1-(1+bE)^2}}\,, \qquad \text{where} \quad b = \frac{I(1+\cos\theta_0)}{\gamma}\,.$$

Here $I = 5.03 \times 10^{18}$ m^{-2} is the density of water molecules in the surface layer, γ is the surface tension, θ_0 – the initial contact angle.

3 Results and Discussion

The method of water spectra reflects the existence of Hydrogen energy bonds between water molecules – the so called structure of water [2]. The hydrogen bonds forming the strongest bond among water molecules is depicted in Figure 2.

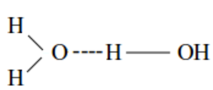

Figure 2: H-bond between two water molecules, represented by a dashed line. The H_2O molecule on the right of the dashed line is a proton donor, and the H_2O molecule on the left of the dashed line is a proton acceptor.

An example of water spectrum of snow water from the peak of Moussala is given in Figure 3. The curve with circles corresponds to the results of measurement of the snow water sample and its closeness to the curve of the control sample (squares) implies that there is no significant pollution on the snow water sample.

The natural waters monitoring is of increasing interest due to the increasing human interference with the ecosystem expressed by the intensified pollution.

The process of global pollution, e.g. the increasing emission of gases in the atmosphere influence the waters even in clean areas as the mountains.

Water spectra are sensitive to physical influences and chemical ingredients. So they can represent the integral influence of the ecosystem on natural waters [4-12].

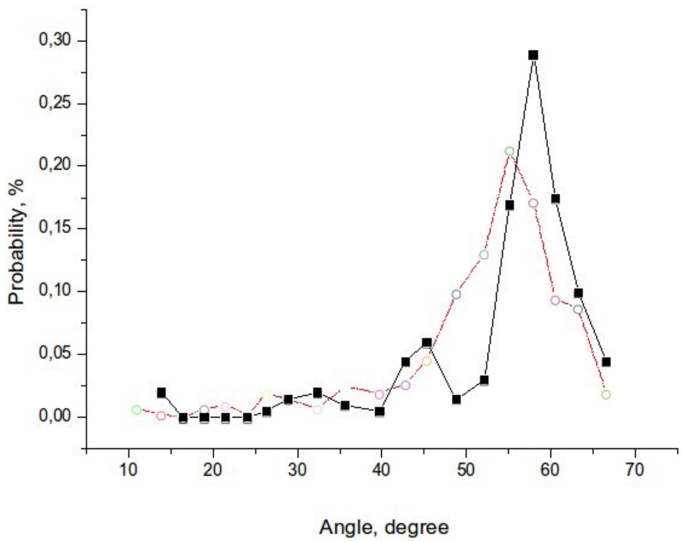

Figure 3: Water spectra of snow water from the peak of Moussala (circles) and control sample (squares).

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