MOLECULAR SCATTERING OF LIGHT IN PURE SUBSTANCES

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ABSTRACT

When light passes through pure media, it is scattered by fluctuations in the density of the media. Due to scattering, the intensity of the light flux passing through the medium changes.

Keywords. *pure environment, molecular scattering, crystals, intensity, fluctuation, adiabatic compressibility.*

АННОТАЦИЯ

Когда свет проходит через чистые среды, он рассеивается за счет флуктуаций плотности среды. За счет рассеяния изменяется интенсивность световых условий, проходящих через среду.

Ключевые слова. *чистая среда, молекулярное рассеяние, кристаллы, интенсивность, флуктуация, адиабатическая сжимаемость.*

ANNOTATSIYA

Yorug'lik toza muhitlardan o'tishida muhitning zichligini fluktuatsiyalarida sochiladi. Sochilishlar tufayli muhitdan o'tayotgan yorug'lik oqimining intensivligi o'zgaradi.

Kalit so'zlar: *sof muhit, molekulyar sochilish, kristallar, intensivlik, fluktuatsiya, adiabatik siqilish.*

INTRODUCTION

In the article, I will talk about the types of light and in what cases it has what kind of scattering, what is combinatory scattering, when it occurs, what parameters change in this scattering, and how its spectra are in substances.

EXPERIENCE AND METHODS

According to the results of previous research, the previously mentioned difference was considered the only difference in the spectrum of incident and scattered light. However, a careful examination shows that in the spectrum of scattered light, there are additional lines (satellites) in addition to the lines characterizing the incident light, and each line of the incident light stands next to it. Since satellites come near any spectral line of incident light, we are looking for and trying to find an answer to the question under what conditions these satellites can be noticed. There are different mechanisms of light scattering in crystals, and the inclusions and defects in the light medium are generally scattered due to the presence of inhomogeneities in the medium. scattering is called relay scattering. However, even when the environment is absolutely clean, light can be scattered by fluctuations in the density of the environment. Thermal fluctuations of the atoms and molecules that make up the environment create inhomogeneities in the environment. Such a mechanism of scattering is called scattering of light due to fluctuations in the density of the medium. (G. S. Landsberg and colleagues, 1927h-1930). In this type of scattering, the wavelength of light is not very important. Therefore, this type of scattering is also called molecular scattering.The physical reason for the scattering of light in a pure substance was shown by Smolukhovsky, which is as follows: due to the statistical nature of the thermal behavior of the molecules of the medium, density fluctuations appear in the medium, and these fluctuations are especially large at the critical point.Density fluctuation Δr causes refractive index fluctuation Δe or dielectric permittivity Δn fluctuation (e≡n2), which is actually optical inhomogeneity. Far from the critical point, the fluctuations are not as large as in the critical point region. and in a pure substance, Light is scattered due to those fluctuations. In 1910, Einstein created a quantitative theory of molecular scattering of light away from the critical point: this theory is based on the appearance of optical inhomogeneity in the medium due to fluctuations of the dielectric constant Δe based on the idea.In this case, the intensity of the scattered light is determined by the optical inhomogeneity caused by fluctuations. Since the intensity of the scattered light does not depend on the sign of $\overline{\Delta\varepsilon}$, the intensity is proportional to $\Delta\varepsilon^{2}$. A simple electrodynamic calculation shows that the intensity is:

$$I = I_0 \frac{\pi^2}{2\lambda^4 L^2} V^* V \overline{(\Delta\varepsilon)^2} (1 + \cos^2\theta) \tag{1}$$

Here V* is the volume in which the fluctuation occurred, which is small compared to the length of the light wave, but contains many molecules. Other symbols are taken as in the formula.Now the measure of optical inhomogeneity in molecular scattering of light is $(\overline{\Delta\varepsilon})^2$. If we consider that $(\overline{\Delta\varepsilon})^2$ fluctuations are determined by only two thermodynamic variables consisting of density and temperature or ρ pressure and S entropy, then

$$\Delta\varepsilon = \left(\frac{\partial\varepsilon}{\partial p}\right)_S \Delta p + \left(\frac{\partial\varepsilon}{\partial s}\right)_p \Delta S; \quad (\overline{\Delta\varepsilon})^2 = \left(\frac{\partial\varepsilon}{\partial p}\right)_S^2 \overline{\overline{\Delta p^2} + \left(\frac{\partial\varepsilon}{\partial s}\right)_p (\overline{\Delta S})^2} \tag{2}$$

where Δr, ΔS are fluctuating changes of pressure and entropy, the indices in the derivatives show what quantity remains unchanged when taking the differential. Here it is noted that the fluctuations Δr and ΔS are statistically independent and therefore ‾ΔrΔS=0. The theory of fluctuations allows to express the quantities Δr^2 and ΔS^2 through the thermodynamic characteristics of matter and (1) the relationship

$$I = I_0 \frac{\pi}{2\lambda^4 L^2}\frac{V}{L^2}\left\{\left(\rho\frac{\partial\varepsilon}{\partial\rho}\right)_S^2 \beta_S kT + \left(\frac{1}{\sigma}\frac{\partial\varepsilon}{\partial T}\right)_p^2 \frac{\sigma^2 kT^2}{c_p\rho}\right\}(1+\cos^2\theta) \quad (3)$$

allows you to visually describe it, here

r is the density of the medium (g/cm3),

T—absolute temperature,

bS is adiabatic compressibility,

s is the coefficient of thermal expansion,

sr — heat capacity of 1 g of substance under constant pressure conditions,

V—Light scattering volume.

RESULTS

In the formula (3), the first term in the big bracket indicates the intensity of light scattered due to adiabatic fluctuations of density (pressure fluctuations), and the second term indicates the intensity of light scattered due to isobaric fluctuations of density (entropy fluctuations). the following approximate equation can be written:

$$\left(\rho\frac{\partial\varepsilon}{\partial\rho}\right)_S^2 \approx \left(\frac{1}{\sigma}\frac{\partial\varepsilon}{\partial T}\right)_p^2 \approx \left(\frac{\partial\varepsilon}{\partial p}\right)_S^2 \quad (4)$$

Einstein also considered optical inhomogeneity caused by fluctuations in solute concentration (in which the dielectric constant is considered concentration-dependent).

The development of Einstein's theory by applying it to the scattering coefficient of light in various polymers and oxides (Debay) is the most important way to determine the molecular weight and structure of polymer molecules whose dimensions are on the order of (or larger) the length of the incident light wave. gave one of the best methods. From measurements of the intensity of light scattered by the atmosphere on a clear day in the mountains, where the atmosphere can be considered free of random dust, the value of Avogadro's number was found to agree satisfactorily with the generally accepted value: 1938 to 1951 The corrected value of Avogadro's number is (61.0 + ±0.8) • 1022 mol -1, and this value is its accepted (60.2± ±0.3) • 1022 mol corresponds very well to a value of -1. Good results were

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also obtained from experiments on light scattering in gases under laboratory conditions (Kabann and his colleagues; according to their latest data, Na = = (61.0 ±0.8)• 1022 mol -1) .

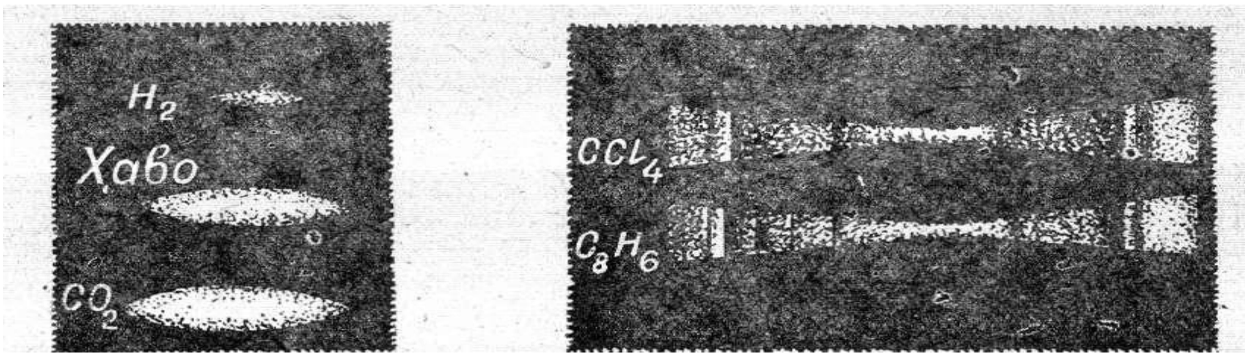

Figure 1 Photographs showing different light scattering of different substances under the influence of the same light flux.

The fact that the scattering of light in a liquid is of a molecular nature was reliably established in the works conducted between 1913 and 1925, during which various aspects of the phenomenon were studied. New careful research on the scattering of light in liquids was carried out with the aim of determining why the theoretical and experimental values of Avogadro sonn do not coincide with each other. At the moment, it can be considered that the difficulties have been overcome: as a result of experimental determination of all quantities included in the formula of the intensity of scattered light, including previously based on unsubstantiated considerations, Avogadro's number is (59 ± 2)-1022 mol-1 (G. P. Motulevich, I. L. Fabelinsky, 1951) There are very important experimental difficulties in measuring the absolute intensity of scattered light, but they can be overcome. You can get an idea about the results of similar measurements from the following information. Photographs of the light scattered by different substances under the condition that all substances are illuminated in the same way are shown in Fig. 1. These pictures give you an idea of the relative scattering power of different substances.

CONCLUSION

Air scatters 2.7•10~7 of the incoming Light flux in an air layer with a thickness of 1 cm (at normal pressure and temperature). Hydrogen scatters 43 times less than air, Argon 1.2, Carbon dioxide 2.6 more, Water (liquid) 185, Benzene (liquid) 1700, Quartz (crystal) 7, Rock salt (crystal) 5.

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