L10 – Photoacoustic effect in gases, liquids and solid states

The photoacoustic effect (EF) was discovered in the late 19th century by Alexander Graham Bell, the inventor of the microphone. It occurs in the tested medium when illuminated with a radiation beam modulated at an acoustic frequency. Due to the light absorption and the periodic heating of the medium, an acoustic wave occurs, It is recorded by a microphone. This type of spectroscopy allows the study of matter surface or internal structure. No need to use photodetectors is the advantage of this technique, however the disadvantage is susceptibility to external acoustic interferences.

In this experiment, EF will be investigated in gases, liquids and glasses contained in resonant systems.

Exercise course:

1) EF test in a mixture of air and nitrogen oxides in a Helmholtz chamber;

2) study of EF in a tube filled with a dye solution as a function of the geometry of the light beam injection, laser modulation frequency and liquid column height and the dye density;

3) study of EF in glass rods as a function of laser modulation frequency and light beam injection geometry;

~~3a) search for 2-photon absorption in a liquid or solid.~~

Entrance requirements:

1) Knowledge of the experimental system structure:

a) laser – physical basis of its operation: phenomena of light – matter interaction, cascade light amplification, optical resonator and its influence of the laser spectrum.

b) phase detector (homodyne detector, lock-in amplifier); Single and double phase solutions

c) generator and oscilloscope (digital);

d) voltmeter, ammeter, microphone, amplifier (input and output resistance).

2) Theory of the photoacoustic phenomenon: equation of a damped oscillator with a periodic stimulating force. Resonance, resonance frequency, dependence of the amplitude and phase of oscillations on the frequency of the stimulating force.

3) Mechanical and electromagnetic standing waves.

4) Energy structure and absorption spectra of atoms, molecules and solids.

~~5) Nonlinear optical phenomena - on the example of two-photon absorption.~~

References

1. W. Demtröder – *Laser Spectroscopy*
2. F. C. Crawford, *Waves*