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Research in Optics Carried out during the Period 1962-1972

Hereafter, an extremely concise survey of the more interesting results obtained in the field of spectroscopy the scientist from the Atomic and Molecular Optics Division, Institute of Physics, Polish Academy of Sciences, and Optics Division, Institute of Experimental Physics, Warsaw University in Warsaw, is presented.

Basing on some new methods of atomic spectroscopy the following theoretical and experimental investigations have been carried out:

A. Optical effects of atomic state coherence:

1. It has been pointed out that under specified conditions the coherence introduced into the ground state is transfered during the process of radiation absorption to the excited state, which results in appearing of a variable component (modulation) at ground state Larmor frequency in the radiation emitted by an atomic system [1].

2. Also, multi-quantum magnetic resonances generate modulation effects in the radiation emission [2].

3. Distribution of the modulation phases over hyperfine and fine components has been given for the modulation of the radiation absorbed by the optically pumped atomic system subjected to magnetic resonance in the ground state [3].

4. Effects caused by introducing coherence to the excited state of mercury have been examined by using amplitude modulation of the exciting radiation [4].

B. Level-Crossing spectroscopy (LC-Spectroscopy)

1. Positions of LC-resonances have been found theoretically for selected alkaline [5].

2. A possibility of improving the resolving power of the LC method has been indicated [6].

C. Longitudinal and transversal relaxation in gaseous media:

1. A puls train method for measuring the longitudinal relaxation time has been worked out [7].

2. Dynamics of the longitudinal relaxation process in the ground state has been investigated for complex gaseous systems (2 alkaline elements and buffer gas) [8].

3. Dynamics of the transversal relaxation process in the ground state for alkaline metals in the presence of buffer gas by the use of the method of fast adiabatic passage has been examined [9].

4. Relaxation processes in the excited state of alkaline metals were studied by the aid of the LC method [10].

D. Pressure induced atomic line broadening for mercury in the region of low pressures of the foreign gas:

1. An agreement of the Jabłoński theory with the experiment has been stated for low pressure krypton and sufficiently low concentration of mercury atoms [11].

2. Existence of the long wavelength band in the mercury spectrum in the presence of krypton and by sufficiently high temperature and an interpretation of the effect was suggested [12].

In the field of molecular optics and quantum electronics the following investigations were carried out:

E. In the course of studies on luminescence of solid solutions of aromatic hydrocarbons the existence of a sharp boundary between the luminescent and non-luminescent regions has been stated, which is caused by a quenching action of the oxygen, penetrating the luminophor. An explanation of the effect was given and its application to the diffusion coefficient determination indicated for the gasses in polymers [13].

F. Further investigations of the previously detected triplet exciton annihilation effect were continued for the naphthalene solid solution [14].

G. A number of lasers both of ruby giant pulse type and gaseous D. C. type have been constructed which were designated to examination of the the multi-photon transitions. The mechanism of the multi photon transition in naphthalene mono-crystals, which were induced by single pulses of a ruby laser was investigated and a new explanation was proposed. In the course of these works a new measurement method for determination of the kinetics of the changes in triplet state population has been worked out, which is based on the paramagnetic properties of the triplet state. The two-photon absorption for 3,4-benzpyrene in organic solid solution induced by both ruby laser pulses and a very low intensity beam produced by a D. C. gas laser was obtained and examined [15].

H. A series of works was carried out dealing with excitation mechanism and transition probabilities investigation in gaseous lasing systems. The investigations were based on measurements of intensity changes in the corresponding spontaneous transition spectral lines. A series of interesting results for He–Ne mixtures and the cadmium vapour was achieved. Among others, new laser transition in the He–Ne mixture was discovered in the infra-red region [16].

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