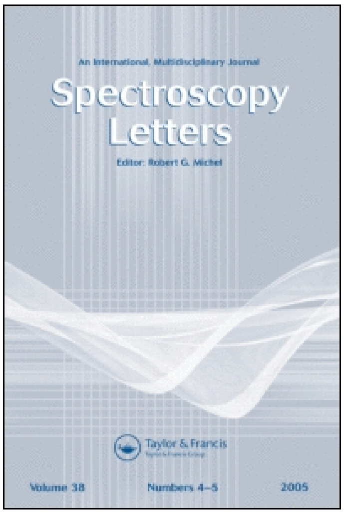

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Optogalvanic Indication of Small Continuous Spectrum Distribution Shift

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OPTOGALVANIC INDICATION OF SMALL CONTINUOUS SPECTRUM DISTRIBUTION SHIFT

Key words: Hollow Cathode Discharge, Optogalvanic Effect, Spectrum Distribution Shift

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ABSTRACT

An optogalvanic method based on the shift of the continuous spectrum frequency distribution is proposed. The accuracy of the shift indication depends on the frequency distribution of the absorbing transitions in the optogalvanic detector spectrum. The absorption in Ne/Cu hollow cathode discharge lamp is analysed in order to investigate the behaviour of the spectrum emitted by a red AC EL panel.

I. INTRODUCTION

To indicate a small shift of continuous spectrum distribution is a nontrivial problem, but of undoubtful importance in many aspects. The shift of a separate spectral line is often used for plasma diagnostic in interferometric measurements [1-3]. Here a method, based on the Optogalvanic (OG) effect measurement is proposed. The method is attractive with the simplicity of the nonlaser OG spectroscopy arrangement.

II. ANALYSIS

1. The OG effect is known as a conductivity change due to resonant light absorption. It characterises the peculiarities of the absorbing optical transition (the coefficient of absorption, first of all) as well as the emission of the illuminating light source. The amplitude of the OG signal depends on these factors simultaneously.

The essence of the method is the measuring of the integral OG signal induced by the investigated spectrum distribution in an OG detector. The necessary requirements are:

i) preliminary information on the type (form) of the light emission frequency distribution $\Phi(\lambda)$;

ii) localization of the main absorption on a certain frequency interval of the OG detector spectrum;

Then the shifted distribution $\Phi'(\lambda)$ in relation to the initial one $\Phi(\lambda)$ reveals by a change of the integral OG amplitude.

2. Let Φ_λ be a monochromatic light beam and S_λ - the OG sensitivity to Φ_λ, i.e. $S_\lambda = dU/d\Phi_\lambda$, where dU is the light induced voltage change. It must be emphasised that the sensitivity S_λ depends, first of all, on the corresponding coefficient of absorption. In the laser OG spectroscopy the OG signal ΔU is proportional to Φ_λ and S_λ: $\Delta U = \Phi_\lambda S_\lambda$. When the light beam is nonmonochromatic, i.e. $\Phi(\lambda) \in [\lambda_1, \lambda_2]$ and the OG detector contains a number of resonant optical transitions in $[\lambda_1, \lambda_2]$ region, i. e. $S_\lambda = S(\lambda)$, the OG response is of integral type

$$\Delta U = \int_{\lambda_1}^{\lambda_2} \Phi(\lambda)\, S(\lambda) d\lambda \tag{1}$$

If the S -function is determined by one absorbing transition mainly and the spectrum distribution is shifted so that $\Phi\,'(\lambda) \in [\lambda'_1, \lambda'_2]$, then the difference between the corresponding $\Delta U_{1,2}$ - signals is

$$\Delta U_{12} = \int_{\lambda'_1}^{\lambda'_2} \Phi\,'(\lambda)\, S_\lambda\, d\lambda - \int_{\lambda_1}^{\lambda_2} \Phi(\lambda)\, S_\lambda\, d\lambda \tag{2}$$

due to the changed spectral density in relation to S_λ (Fig. 1). Taking in mind the requirements i) and ii) the sign of ΔU_{12} suggests the shift direction - case (b), excluding the case (a), where $\Phi(\lambda)^{max}$ and S_λ coincide - here the sign is always $\Delta U_{12}<0$.

If the shifting mechanism increases (decreases) the light source brightness as well the above indication becomes complicated.

3. In the real nonlaser OG arrangement a number of optical transitions may dominate in the absorption of the OG detector. If these transitions are set close to each other in the interval $\Delta\lambda$, the later would determinate the accuracy of the shift indication:

$$\Delta U_{12} = \int_{\lambda'_1}^{\lambda'_2} \Phi\,'(\lambda)\, S(\lambda) d\lambda - \int_{\lambda_1}^{\lambda_2} \Phi(\lambda)\, S(\Delta\lambda)\, d\lambda \tag{3}$$

The Hollow Cathode Discharge (HCD) lamps are most often used as an OG detector. Their spectrum is known to consist of optical transitions belonging to low and high energy levels including that of the ions. Fig. 2 illustrates the absorption by a Ne/Cu HCD lamp ("Narva") within 540 nm and 744 nm. Here, in particular, the light emission of red AC EL panel is localised. The highest optical density of the lamp is between 585 nm and 660 nm. The coefficients of absorption of the optical transitions $1s_i$ - $2p_j$

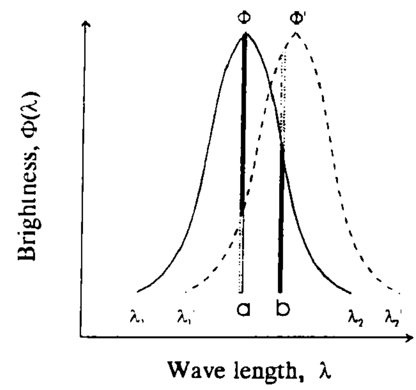

FIG. I: Graphic illustration of the method.

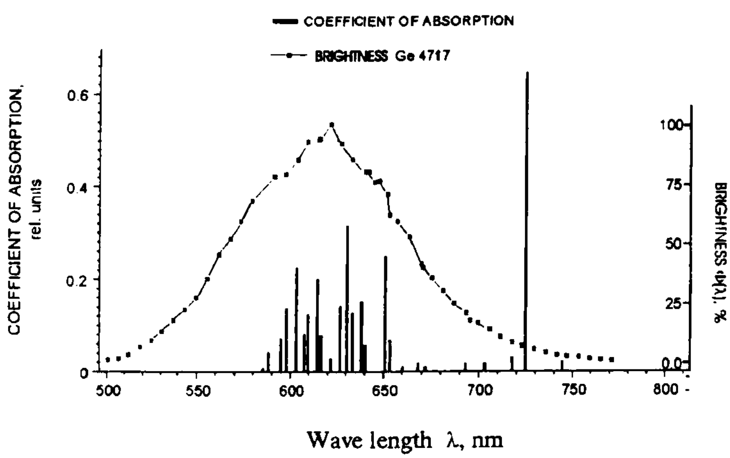

FIG. 2: Absorbing transitions $1s_i - 2p_j$ (540 nm and 744 nm) and emission spectral distribution of a red AC EL panel.

levels are calculated by using our experimental data on the population density. The values of the transition probability A_{ki} are taken from Ref. [4]. The absorption coefficient values in relative units demonstrate the distribution, giving integral OG signal due to illumination by AC EL emission.

A correlation between the absorption, the emission peak and the observed OG signal is established in the preliminary experiments. We hope to report on the $\Phi(\lambda)$ shift in our subsequent work.

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