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### Penning Interaction Ne-As and Optogalvanic Signal Deformation

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## PENNING INTERACTION Ne-As AND OPTOGALVANIC SIGNAL DEFORMATION

**Key Words:** Optogalvanic Effect, Hollow Cathode  
Discharge, Penning Interaction

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### ABSTRACT

The optogalvanic response of Ne-As hollow cathode discharge plasma is found to be deformed depending on the discharge current. Penning Ne-As interaction is supposed and spectroscopically confirmed.

### INTRODUCTION

The use of Hollow Cathode Discharge (HCD) as Optogalvanic (OG) detector stimulates further investigations on the effect of resonant light on plasma conductivity. Here a deformation of the real OG signal in HCD is reported.

### EXPERIMENT

A Ne/As HCD spectral lamp ("Pye Unicam") is irradiated by He-Ne laser (632.8nm,  $1.15\mu\text{m}$  and  $3.39\mu\text{m}$ ). In addition as an illuminating source a filament lamp with

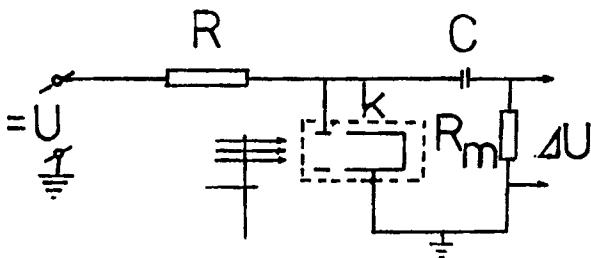


Fig.1. Schematic setup

a high resolution monochromator is used. In this way some  $1s_i-2p_j$  transitions of neon atom are influenced. A standard OG scheme (Fig.1) detects the change  $\Delta U$  of the cathode voltage drop  $U$ .

#### RESULTS AND DISCUSSIONS

The OG signals  $\Delta U$  v.s. discharge current  $i_d$  are detected. In the vicinity of  $i_d=6\text{mA}$  identical signals (Fig.2) for the three laser lines are observed. The form and  $i_d$  localization of the peaks in Fig.2 are found to be independent on the incident light frequency. This fact gives rise to doubt about the OG nature of response  $\Delta U(i_d)$  near  $i_d=6\text{ mA}$ . The following irradiation by spectral lines of  $1s_i-2p_j$  transitions (640.2 nm, 594.5 nm, 540.0 nm, 607.4 nm, 626.6 nm, 585.2 nm) confirms the nonoptogalvanic character of the Ne-As plasma reaction at  $i_d=6\text{mA}$ . The same peak is detected when the lamp is illuminated by the full or partial frequency emission of a Ne/Al lamp. One should note that the metastable  $^3P_2$  neon level irradiated as a low one forms at  $i_d \neq 6\text{mA}$  a real OG signal opposite in sign to the other ones from  $1s_i-2p_j$  transitions and

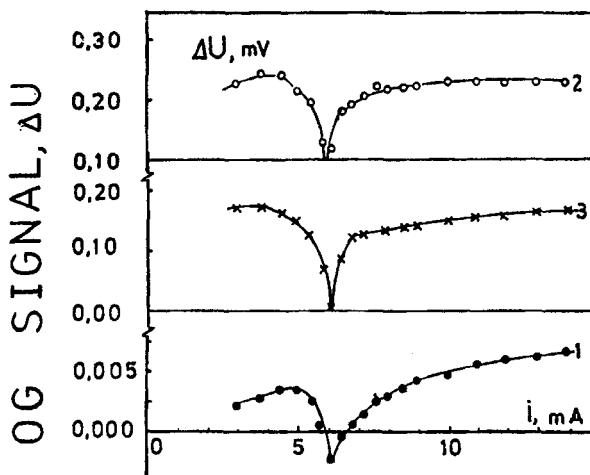
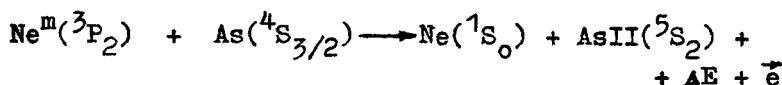


Fig.2. Optogalvanic response of Ne/As lamp ("Pye Unicam"): 1- 632.8 nm; 2- 1.15  $\mu$ m; 3- 3.39  $\mu$ m.

this sign is specific for the metastable level irradiated.

Thus the reason for this light frequency nonselectivity should be a more general one and should be looked for as a bulk Ne-As plasma effect. The closeness between the metastable  $\text{Ne}^m(^3P_2)$  and  $\text{AsIII}(^5S_2)$  levels<sup>1</sup> (Fig.3) is the reason for a Penning process:

/1/



increasing the plasma conductivity. A spectral proof for the process /1/ could be the behaviour of the relevant line intensities. Fig.4 shows the AsIII 191.29 nm ( $^3P_2 - ^5S_2$ ) and AsI 193.7 nm ( $^4S_{3/2} - ^2D_{3/2}^0$ ) spectral line intensities  $I_\alpha$  and  $I_\beta$  respectively as

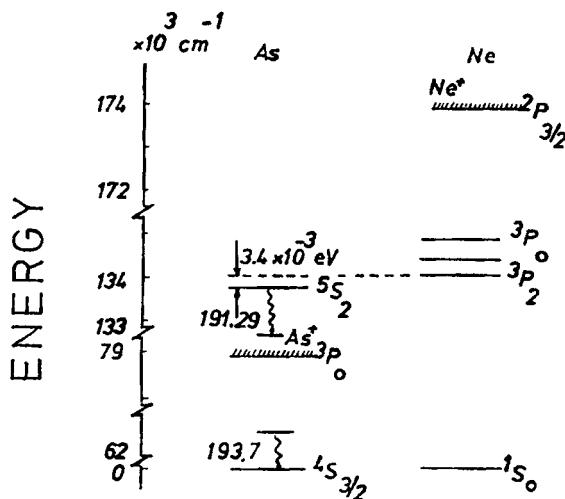


Fig.3. Diagram of the interacting Ne, As and As<sup>+</sup> levels.

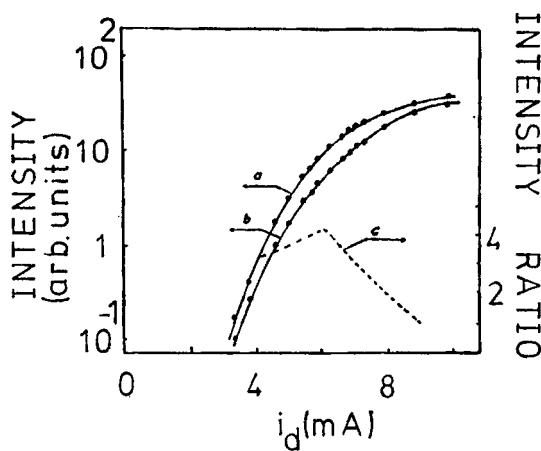


Fig.4. Intensity of AsII 191.29 nm (a) and AsI 193.7 nm (b) spectral lines v.s. discharge current in Ne/As lamp ("Pye Unicam"); c - ratio of the intensities.

well as their ratio  $I_\alpha / I_\beta$ . The upper level of AsII 191.29 nm is populated additionally by the process /1/ creating As<sup>+</sup> ions of 4s4p<sup>35</sup>S<sub>2</sub> state. The other line intensity  $I_\beta$  is not connected with the aforementioned process directly. Then the ratio  $I_\alpha / I_\beta$  should be sensitive to any selective change of AsII<sup>5</sup>S<sub>2</sub> level population. Indeed, curve c (Fig.4) illustrates a peak of the ratio at  $i_d = 6\text{mA}$  where the Penning process takes place. The correlation between  $\Delta U(i_d)$  and  $I_\alpha / I_\beta = \gamma(i_d)$  near 6 mA is an indication that both are based on process /1/ and also that the peaks can not be identified with the real OG effect according to Ref.2,3.

### CONCLUSION

The observed galvanic effect of Ne-As HCD plasma deforms the real optogalvanic response and limits its analytical possibilities. We have detected such a deformation of the time depending OG effect too and its appearance will be analyzed.

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