Publ. Astron. Obs. Belgrade No. 61 (1998), 147 – 150 *Contributed paper*

USAGE OF SPECTROSCOPICAL EXPERIMENTS FOR DETERMINATION OF OTHER PLASMA PARAMETERS

M.M. Popović and D.S. Djordjević
Institute of Physics, Pregrevica 118, Zemun, 11080 Beograd, Yugoslavia
E-mail:marko@exp.phy.bg.ac.yu

Abstract: Electrical gas discharge is a source of plasma in many spectroscopic experiments. In this paper it has been shown that those experiments, with some additional measurements, could be used for determination of other plasma parameters, electrical ones before all. There is an example of measurements in cascade arc and Z-pinch.

1. INTRODUCTION

Electrical gas discharge is being used as a plasma source in many experiments with a purpose, before all, to obtain spectroscopic data. Generally used ones are: classical cascade arc, spark, different kinds of pinches, impulse arc, glow discharge, etc. In those discharges meritorious spectroscopic diagnostics could be done, so that temperature and electronic concentration parameters could be correctly determined. Those two values, with measurements of absolute and often only relative radiation intensities in a field observed enable relevant interpretation of spectral line width and shift, continuous discharge origin and intensity, spectral series merging, etc. Due to possibility of reliable interpretation of spectroscopic values, in those measurements other plasma parameters are not being taken into account enough. Very often even basic technical data about discharge, such as volt-ampere characteristics are not being determined.
In this paper at the example of cascade arc and Z-pinch it is shown that in these experiments, with some additional measurements, data about other "useful" values could be obtained. The data about electrical conductivity from an arc

plasma are obtained and compared with the data from an pulse arc measurements. The data from Z-pinch are used for a determination of a very interesting resistant dependence of current during the discharge. A comparison of the data with data from other experiments has been done.

2. WALL-STABILIZED STATIONARY ARGON ARC

A high-pressure wall-stabilized arc used in this experiment predicted especially for spectroscopic measurement is described in Goldbach et al. (1972). A plasma channel (length: 70mm; diameter: 5mm) is inducted within six electrically insulated copper plates (thickness: 10mm).

The plates are water-cooled. The arc is burning between two water-cooled tungsten cylinders. The whole device operated at a chosen pressure within a high-pressure steel cylinder. Four fused silica windows, located in side walls and the electrodes, allow either end-on or side-on observations. The pressure in the chamber was measured by membrane pressure gauge connected to a digital voltmeter. We have used additional procedure for performed electrical measurements. The axial electrical field strength was measured as a function of arc current and pressure. Each plate was individually connected to a stepping switch and the voltage drop between two successive plates was measured using a digital voltmeter. The slope of the linear part of the voltage distribution versus the plasma length yields the axial field strength. This method excludes electrode drops in the plasma field determination. The arc current was measured using a shunt in the power line, Goldbach et al. (1978).

In that way, with known arc current, axial component of the electrical field strength and corresponding radial temperature distribution T(r) we were able to determine electrical conductivity by well known procedure, Popović (1986). The electrical conductivity value obtained by the procedure is presented at Fig. 1. in form $\sigma(T, p=\text{const.})$ and compared with the value obtained in pulse arc.

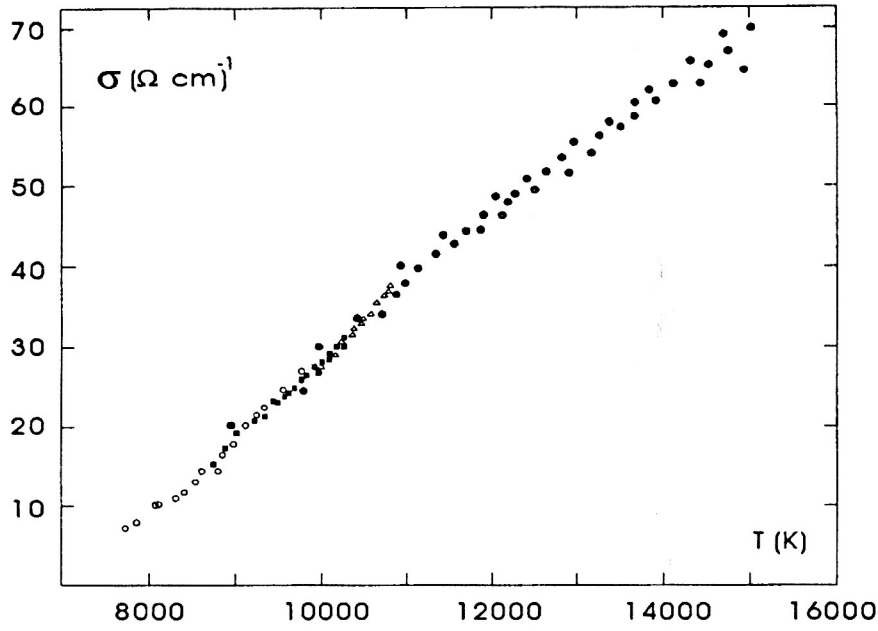

Fig. 1. Plasma electrical conductivity: O - wall stabilized arc E=15V/cm;
■ -wall stabilized arc E=18V/cm ; Δ- wall stabilized arc E=23V/cm;
● - pulsed arc.

3. RESISTANCE OF THE BEGINNING OF HIGH CURRENT DISCHARGES

The knowledge of the main discharge characteristics (current, resistance, voltage, etc.) during the transition period between a breakdown and a steady state regime of high current discharge is interesting both for practical purposes (calculation of circuit elements) and for physical reasons (comprehension of the main processes occurring in the discharge). Many papers have studied the development of the spark, suggesting models and relations between different quantities, for instance resistance and current, Popović et al. (1976) to be used. In order both to investigate dependence between particular parameters and especially to determine a function R(i,d,r,t) we have used Z-pinch, which is mainly applied in spectroscopic measurements, Fig. 2.

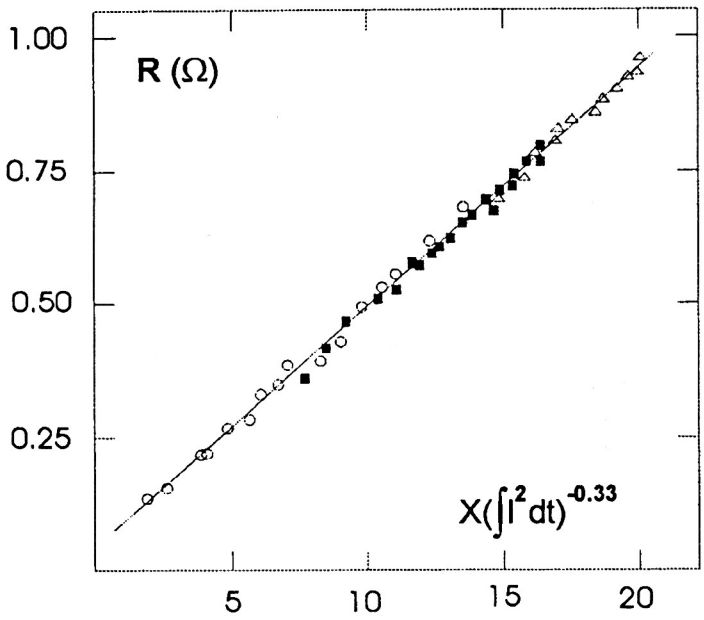

Fig. 2. Resistance versus current integral in case
Z-pinch for different lenghts: o X = 5 cm, ■ X = 10 cm, Δ X = 15 cm

4. CONCLUDING REMARKS

It is shown that spectroscopic experiments with electrical gas discharge as a plasma source could be used for determination of other, particularly electrical plasma parameters.

Acknowledgment: This paper is supported by the Ministry for Science and Technology of Republic of Serbia.

References

Goldbach C., Nollez G. and Peyruraux R.: 1972, JQSRT **12,** 1089.
Goldbach C., Nollez G., Popović S. and Popović M.M.: 1978, Z. Naturforsch. 33a,11.
Popovic M. M. et al.: 1976, *in Gas Discharge* (ed. C. Grey Morgan), IEE Conf. Publ. No. 143. London.
Popović M.M. and Popović S.:1986, in Strongly Coupled Plasma Physics (eds. F.J. Rogers and H. E. Dewit), Plenum Press, N.Y.