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Book 2/1

APPLIED PHYSICS IN SERBIA-APS

**CONTRIBUTED PAPERS AND
ABSTRACTS OF INVITED LECTURES**



Editors:

S. Koički, N. Konjević, Z. Lj. Petrović and Đ. Bek-Uzarov

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APPLIED PHYSICS IN SERBIA
CONTRIBUTED PAPERS



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НАУЧНИ СКУПОВИ

Књига ХСVШ

ОДЕЉЕЊЕ ЗА МАТЕМАТИКУ, ФИЗИКУ И ГЕО-НАУКЕ

Књига 2 / 1

ПРИМЕЊЕНА ФИЗИКА У СРБИЈИ-ПФС

ЗБОРНИК РАДОВА

И

АПСТРАКАТА ПРЕДАВАЊА ПО ПОЗИВУ

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AIR ION DETECTION NEAR THE GROUND

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Abstract. The Gerdien type electrostatic condenser was built with the aim to detect small air ions near the ground. Absolute calibration of the air flow rate through its sensor enables urban measurements of the air ion concentration. A computer acquisition and storage of the data are realised in several points in Serbia (Novi Sad, Zemun, and Belgrade), so the monitoring is possible.

1. INTRODUCTION

Air ions are natural constituents of the atmosphere. Typically, the ionization by both radioactive and cosmic rays generate small air ions at a rate of 10 *ion pairs per cm³ per second*, near the ground at sea level. As a consequence, the air ion concentration in the lowest atmospheric layer is 500 *ions cm⁻³* approximately, in the fair weather conditions.

Primary air ions generated by mechanisms mentioned above are positive nitrogen and oxygen ions: N_2^+ (IP=15.6 eV) and O_2^+ (IP=12.2 eV), in accordance with percentage contribution of these molecules in the air. Also, negative oxygen ions form easily because of its electron affinity (EA=0.44 eV). Nitrogen molecule hasn't affinity for electrons. Knowledge of electron affinities can be combined with that of ionisation potentials of atmospheric atoms, molecules and their radicals, to predict which of them can remove electrons from others. Time evolution of these ions depends strongly of the relative humidity and the pollution of the air.

2. METHODS AND INSTRUMENTATION

Detection of air ions is possible by using their electrical properties. If cylindrical condenser method is applied, potential difference of only 30 V is enough for total collection of small ions between two condenser electrodes [1]. Ions of the same sign as the outer electrode are

repelled to the central electrode which collects only these of high mobility. Low mobility (massive or large) ions practically do not affect this measurement.

The ion current is of the order of $10^{-15} A$ (femtoampers). So, special care is needed in construction and insulation. Contact potential difference within the measurement circuit, and chemical potentials of sensor surfaces in the atmosphere as an electrolyte, must be under control.

3. MEASUREMENTS

Negative air ion concentration measured by the CDJ 04AT detector (fig. 1) during the partial solar eclipse 1999, in clear correlation with the relative humidity measured at the same time, was checked in the indoor laboratory experiment. A baby incubator »Medicina 97« was used as the crucial part of the experiment. Strong correlation between negative air ion concentration and relative humidity was found. This fact should be very important for medical investigation in which the air ion concentration in a baby incubator has to be under control.

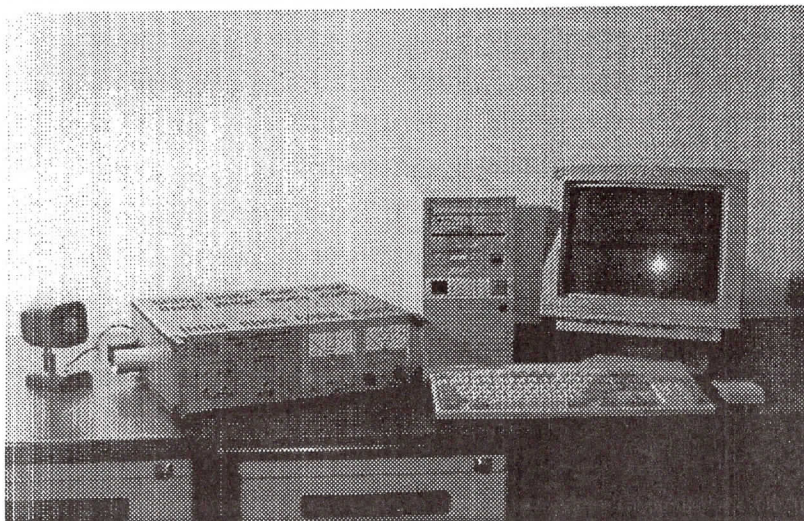


Figure 1. From left to right: Air ion generator, CDJ04 AT detector, and PC.

Another measurement was performed in Soko Banja, the spa very well known as a place with a large amount of radon ($Rn\ 222$) emanation. We have determined relative concentration of this radioactive atom by using a long-term track-detector of $5.5\ MeV\ \alpha$ -particles, which are predominantly responsible for ionization of air molecules up to $500\ m$ above the ground. According to the results obtained in both, radon and air ion measurements, we have located the Banjica place as the point, with higher air ion concentration in this region at that time (the last week of the August 1999).

To compare the results obtained with the CDJ 04AT, which operates not so simple as its simplicity might imply, we have built another, plane-electrode ion detector. Also, a holder of the sensor, covered by a special plastic material (which is not very good insulator) is designed to keep the equipotential surfaces near the measuring place as unperturbed as possible.

4. CONCLUSION

The air ions affect human health similar as other meteorological parameters. Atmospheric electricity is a part of meteorology. But, the origin of the Earth's electric field is not satisfactory explained as yet [2]. Physical experiments related to the atmospheric electricity are not directed to such fundamental subjects only. Also, very practical questions are under consideration, as it is illustrated in this work. Our attention is concentrated to the instrumentation, especially the Gerdien condenser, which is at present day electronics and material technology, far easier to build in an appropriate way for practical purposes.

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