All That You Never Wanted to Know About Breakdown

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This talk represents an overview of Prof. Zoran Lj. Petrović's impact on the studies of electrical gas breakdown. The starting point will be his work with late Art V. Phelps and co-workers, which is a key reference in the field. Papers, such as [1-4], represent a comprehensive revision of Townsends' theory of breakdown and low-current low-pressure discharges. These papers show how atomic physics, swarm physics, surface interaction, and discharge physics are connected through the phenomenology of gas breakdown. More importantly, these early studies unlocked an entire field that is still very active, proving that the ground principles laid in [1-4] are valid even in a wider range of conditions than initially assumed. Laboratory for Gaseous Electronics at the Institute of Physics Belgrade continued the work along these lines to this day.

The work initiated in ref. [5] has shown that recommendations and predictions made by Petrović, Phelps *et al.* [1-4] are valid, not only in the near-breakdown conditions, where spatially constant electric field and absence of space charge allow swarm modeling, but also under the highly non-local conditions, where kinetics is considerably changed. Following papers, such as [6], pushed the story a step further, by including kinetics of ions and fast neutrals at high reduced electric fields. A comprehensive review of ionization coefficients in pure gases and gas mixtures, based on [4] was presented in [7], and extended to the analysis of secondary electron yields in [8]. The same principles scaled down to micrometer dimensions in [9]. The significant advance in the field was made by reducing the time scale in [10], where we were able to follow early stages of the breakdown and development of higher current discharges and make a final step in understanding instabilities, such as oscillations and constrictions of the non-equilibrium discharges.

The most recent work in this field is directed to studies of a breakdown in liquids of interest for a wide range of interesting applications [11], which will require significant adjustments in the description of the electron; ion, fast neutral - molecule collisions.

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