Title : **Non-equilibrium plasmas at high pressures**

Acronym : O6

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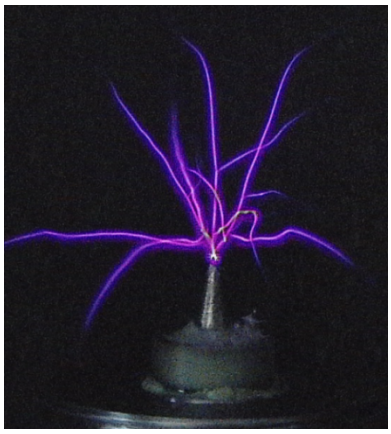
Pre-requisites : First year of MSc in Physics or Engineering Schools.

Credits : 3 ECTS

Language : French / English

Keywords : Out-of-equilibrium plasmas - Electrical discharges - Streamers – Townsend mechanism - High pressure diagnostics - Non-equilibrium kinetics-Atmospheric pressure.

The UE "High Pressure Cold Plasmas" aims to describe the basic concepts associated with high pressure non-equilibrium plasmas. Non-equilibrium plasmas are plasmas where an imbalance is created between the electronic population capable of acquiring energies as high as ten eV and other species (atomic and/or molecular, neutral or ionized, in their ground or excited states) which are maintained at temperatures below a few thousands Kelvin. This imbalance is most of the time generated as soon as the plasma is created by the application of a strong anisotropic electric field to which the electrons are mainly sensitive. The specificity of "high pressure" plasmas lies in the importance of collisions between species (electrons / neutrals, ions / ions, neutrals / neutrals, etc.) and their effects on the characteristics of the plasmas considered.



Filaments of streamer discharges in atmospheric air

The objectives of the course are in **the first part** to highlight the differences observed with low pressure plasmas (Townsend theory, Paschen's law, similarity laws, etc.), and to present the creation mechanisms specific to high pressures (space charge, streamer and ionization wave, Meek criterion,…) through experimental results and simulation. The techniques for characterizing these filamentary plasmas will also be presented: electrical methods, fast imaging, emission and absorption spectroscopy, laser spectroscopy, etc).

A **second part** is devoted to the reaction and the radiative properties of these plasmas by focusing on the non-equilibrium kinetics and the primary chemical reactivity at high pressure. A presentation is made of the key primary species involved in this kinetics (densities, temperatures and energy distributions). The main principles according to which the energy of the plasma is distributed over the different excitation levels of atoms and molecules (electronic, vibrational, rotational) and how this energy can relax or transfer from one species to another are described.

A third part focuses on the "techniques" used to temporally stabilize and spatially "homogenize" the properties of high pressure cold plasmas, and thus allow their use for various applications, and on the other hand on the advances in terms of research concerning, among other things, the generation of plasmas under extreme conditions of electric field, pressure, or plasmagenic medium (liquid, two-phase medium, etc.).