

Non-equilibrium as the cornerstone of collisional low-temperature plasmas: cross sections, kinetic phenomena and real world applications

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Abstract: Low temperature plasmas have been the basis for a vast number of applications, ranging from light sources, nano-electronics tools to new medical and agricultural applications. The key ingredient opening doors to so many different applied technologies and techniques is the non-equilibrium nature of such plasmas. Manifestations of non-equilibrium are numerous and very different. As general laws cannot be developed, low temperature plasmas have often been considered as lacking the fundamental nature. That view is, however, equivalent to absolute application of reductionism as a principle in seeking the fundamental. With any two non-equilibrium plasmas being so different, one must seek the intellectual underpinnings of the low temperature plasmas in the search for the elementary data (mostly scattering cross sections), understanding and reshaping collective kinetic phenomena and using them to tailor specific plasma sources for specific applications. In other words, the common fundamental thread is in learning how to predict controlled plasma sources with desirable properties. In this presentation we shall return to the swarm technique of obtaining the cross sections and how those affect some specific applications. Furthermore we shall observe how electron collisions establish properties of the breakdown in RF fields where production of secondaries in collisions with surfaces is not required to achieve a self-sustained discharge. We shall address systems where ionization is due to the presence of free positrons, namely the gas filled positron traps.

Kinetic phenomena have been defined in the physics of non-equilibrium plasmas as the manifestation of their non-equilibrium nature. We shall illustrate the complexity of non-equilibrium in one example of plasma, atmospheric plasma jet. It has been shown to be a very effective tool to control production of reactive species needed to activate the immune response of the human immune system cells to tumour cells. The fundamental understanding of kinetic phenomena provides ample opportunities for a large number of applications of low-temperature plasmas that are at the front of modern technologies.

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