Experimental investigation of the interaction between two fireballs in low-temperature plasma

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Mesoscale science has to bridge the gap between nanoscience and the macroscopic world. Collective behaviour of large numbers of atoms, molecules and nanoscale components enables the creation of macroscopic systems and their control [1].

In plasma physics, a typical example of a mesoscopic structure is a fireball, an intensely luminous complex space charge structures consisting of a positive inner core (an ion-rich plasma) confined by an electrical double layer which sustains a potential jump, i.e. an electric field [2]. The stability of the double layer is assured by electrostatic forces that act as long-range correlation forces between the two adjacent opposite space charge accumulations (electrons and positive ions).

Here, we report on the interaction between two simultaneously excited fireballs in dynamic states. Two plane electrodes of 10 mm diameter each are immersed in the low-temperature plasma of a Double Plasma machine and positively biased above the ionization potential of the working gas. We observed a perfect synchronization between the dynamics of the two structures under all experimental conditions. In particular we investigated how the dynamics of the fireballs are influenced by the experimental conditions such as the distance between the two electrodes, the voltages applied on the electrodes and the plasma density. Interesting phenomena were observed when the fireballs are in contact with each other. Maximum values of the fireball dynamics frequency were recorded for certain values of the distance between the electrodes (corresponding to the case in which the fireballs are in contact) and the voltages applied on the electrodes, respectively.
