Maxwell Prize Talk: Scaling Laws for the Dynamical Plasma Phenomena

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The scaling and similarity technique is a powerful tool for developing and testing reduced models of complex phenomena, including plasma phenomena. The technique has been successfully used in identifying appropriate simplified models of transport in quasistationary plasmas [1, 2]. In this talk, the similarity and scaling arguments will be applied to highly dynamical systems, in which temporal evolution of the plasma leads to a significant change of plasma dimensions, shapes, densities, and other parameters with respect to initial state. The scaling and similarity techniques for dynamical plasma systems will be presented as a set of case studies of problems from various domains of the plasma physics, beginning with collisionless plasmas, through intermediate collisionalities, to highly collisional plasmas describable by the single-fluid MHD.

Basic concepts of the similarity theory will be introduced along the way. Among the results discussed are: self-similarity of Langmuir turbulence driven by a hot electron cloud expanding into a cold background plasma [3]; generation of particle beams in disrupting pinches [4]; interference between collisionless and collisional phenomena in the shock physics [5]; similarity for liner-imploded plasmas [6]; MHD similarities with an emphasis on the effect of small-scale (turbulent) structures on global dynamics [7]. Relations between astrophysical phenomena and scaled laboratory experiments will be discussed.