Guest Editorial
Dusty Plasmas in the Light of the Caribbean Sun

THE PAST TWO decades have seen tremendous growth in the field of dusty or complex plasma physics. In this system, a third charged species—the charged microparticles (i.e., "dust")—is added to the usual ion, electron, and neutral particle constituents of a plasma. The microparticles can range in size from nanometers and to several hundred micrometers in diameter and become charged in the plasma environment with as few as one or two elementary charges (e.g., in the space environment) up to hundreds of thousands of elementary charges (e.g., in a laboratory experiment).

Dusty plasmas are ubiquitous in technological applications and in astrophysics. They can be formed under laboratory conditions (e.g., plasma processing reactors, laboratory experiments, fusion experiments) with sizes of the dust cloud of a few millimeters to astrophysical systems (e.g., planetary rings, comet tails, nebula) that are millions of kilometers across.

The presence of the charged microparticles in the plasma can lead to significant modification of the bulk plasma parameters such as the charge distribution and potential profile. This also introduces new physical processes into the system, e.g., effects associated with plasma recombination on the particle surface, particle charge variation, etc. Microparticles can change properties of usual acoustic waves in a plasma (e.g., dust-ion acoustic wave). Furthermore, the presence of heavy charged particles gives rise to new wave modes (e.g., dust-acoustic wave). Thus, the wave behavior in complex plasmas can be significantly different from that in multicomponent plasmas.

An important feature of dusty plasmas is the introduction of strongly coupled phenomena into the plasma. This includes observations of both liquid-like and solid-like states formed by the charged grains. The solid, crystalline state—so-called "plasma crystals"—form two- and three-dimensional (2-D, 3-D) lattices. Moreover, the fact that dynamic processes in a plasma species, i.e., the dust, becomes visible on a kinetic ("atomic") level makes the field of dusty plasmas of interest to neighboring disciplines such as condensed matter or material science.

New discoveries are continuing to fuel excitement about the field of dusty plasmas. Recent topics that have generated a great deal of interest in the community include observations of Mach cones and solitons in plasma crystals as well as turbulent flows in liquid plasmas. At the same time, because of the large size of the microparticles, gravitational effects can play a significant role in determining the properties of dusty plasmas. Microgravity investigations of dusty plasmas using sounding rockets flights and parabolic flights have begun recently. In addition, a series of experiments performed onboard the International Space Station (ISS) with the "PKE-Nefedov Laboratory" [1] showed rich possibilities to study basic phenomena (e.g., waves, 3-D crystals, phase transitions, fluid behavior, coagulation, etc.) under microgravity conditions.

This Special Issue on Dusty Plasmas, a continuation of Special Issues in April 1994 and April 2001, gives a snapshot of the progress in dusty plasma research in recent years. Notably, many of the papers in this Special Issue were presented at the Tenth Workshop on the Physics of Dusty Plasmas, which was hosted by Auburn University and the University of the Virgin Islands and was held on the island of St. Thomas, United States Virgin Islands, in June 2003.

Readers of this Special Issue are presented with a series of articles that span the entire range of dusty (complex) plasma investigation ranging from fundamental investigation of microparticle charging to results of laboratory studies—including microgravity studies to dust in the astrophysical environment. Theoretical, computational and laboratory investigations are all well represented in this Special Issue.

As the dusty plasma field has grown, a number of national [2], [3] and international [4], [5] conferences have been dedicated to the scientific discussion of dusty plasmas. For persons interested in this field, there are a number of excellent references that will provide you with an introduction to this field. Among them are a discussion of dusty plasma in the solar system [6], a recent review article [7], and a new monograph on dusty plasmas [8].

We wish to extend thanks to both the authors and the referees for their contribution to this Special Issue. Without your participation, we could not have produced this document. The Guest Editors represent the "next generation" of dusty plasma researchers—i.e., all the Guest Editors are in their mid-30s to early-40s. We express our thanks to the dusty plasma community for entrusting us with this responsibility. For graduate students and new researchers to dusty plasmas, we believe that this is a signal of the vitality of this field and it suggests that dusty plasmas will have a long and bright future.

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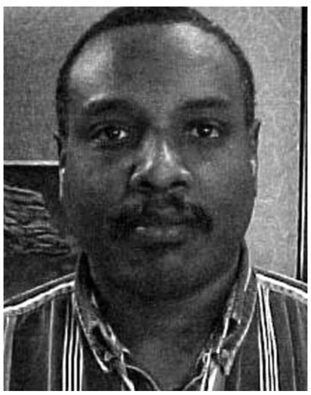

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