Nuclear neighbors mull their fate

Confronting the Bomb
Pakistan and Indian Scientists Speak Out

Edited by Pervez Hoodbhoy

Reviewed by Frank Charles Barnaby
The Project on Peace and Security in South Asia is run by Princeton University’s Program on Science and Global Security. One of the project’s visiting scientists in 2011 was leading Pakistani nuclear physicist Pervez Hoodbhoy, who has taught at Islamabad’s Quaid-i-Azam University, where he was chair of the physics department, and at the Lahore University of Management Sciences.

Researchers with and visitors to the Princeton project have published numerous papers about the dangers posed by nuclear policies in India and Pakistan. Confronting the Bomb: Pakistani and Indian Scientists Speak Out is a collection of 17 of those papers. The roughly 400-page volume, edited by Hoodbhoy, includes essays written by him and Princeton project director Zia Mian, an expert on nuclear weapons and nuclear energy policy in South Asia and on nuclear disarmament and peace.

The essays, which address nuclear politics in South Asia, focus on the role of scientists in India’s nuclear weapons program and on the historical influence of the US on the establishment of Pakistan’s nuclear program. They also discuss the effects of the growing religious and nationalist divisions in both countries; the implications of an “Islamic bomb” on security and the proliferation of nuclear weapons and technology; the risks and consequences of nuclear war in South Asia, with a focus on the India–Pakistan dispute over the Kashmir region; and the catastrophic consequences of using nuclear weapons against the densely populated South Asian metropolises. Two essays explain why adding more nuclear reactors to generate electricity in Pakistan and India is not the solution to their energy crises.

John Polanyi, a recipient of the 1986 Nobel Prize in Chemistry, writes in the preface, “One source of nuclear folly that the present account brings out in the India–Pakistan context—but it is endemic—is the investment of great influence in a few people. There is a deficiency, often times an absence, of public debate where matters relating to a nation’s ‘secret’ arsenals are concerned. Thus, India appears to have committed itself to the nuclear path before there was any consideration of the likely Pakistani response, which, of course, to acquire its own nuclear weapons. On 18 May 1974, India tested a nuclear weapon, calling it “a peaceful nuclear explosion.” And in May 1998, India conducted five more nuclear weapons tests: three on 11 May and two on 13 May. Then on 28 May Pakistan followed suit; it detonated five nuclear devices and became the world’s seventh nuclear weapons country.

Reportedly, Pakistan now has about 100 nuclear weapons in its arsenal (India reportedly has about 90) that are deliverable by aircraft and ballistic missiles. The country is steadily expanding its nuclear capabilities and developing and deploying new nuclear weapons delivery systems, particularly ballistic and cruise missiles. If Pakistan goes on expanding at the present rate, its nuclear arsenal will double to about 200 nuclear warheads in a decade.

The international community has very good reasons to be generally more concerned about Pakistan’s nuclear arsenal and its nuclear command-and-control systems than about India’s. One is the terrorist activities of Al Qaeda and the Taliban in the country. In the past three years, two highly secure military bases have suffered major attacks. Those attacks have renewed and heightened international anxiety about nuclear safety and security in a country that is politically unstable.

Another is Pakistan’s opposition to the international Fissile Material Cut-off Treaty under discussion at the 65-nation Conference on Disarmament, located in Geneva. That stance indicates the country’s unwillingness to consider capping its fast-growing nuclear arsenal. It seems that the world will have to live with Pakistan’s rapidly increasing nuclear power.

Bringing Pakistani and Indian scientists together to describe the nuclear predicament of their two countries, Confronting the Bomb is an excellent and authoritative primer for the debate about one of today’s main global problems. The book reads well and treats the topic comprehensively at a suitable length. Hopefully, political leaders, academics, journalists, and other interested parties in nuclear weapons issues will read it.

Complex Plasmas and Colloidal Dispersions
Particle-Resolved Studies of Classical Liquids and Solids

Alexei Ilyev, Hartmut Löwen, Gregor Morfill, and C. Patrick Royall

Charged particles 1–10 microns in size and suspended in an ionized gas constitute what is called a complex, or “dusty,” plasma. The same particles suspended in a liquid make a colloidal dispersion. Depending on the nature and strength of the interactions between them, the particles in either system can adopt structural arrangements that are the analogs of atomic gases, liquids, and solids. A striking feature is that because of the long range of the Coulombic repulsion between the particles, both plasma and colloidal crystals can be dilute, with lattice spacings of many particle diameters. Particles in this size range can be imaged accurately for the determination of structure, and their motions can be followed by video microscopy.
Complex Plasmas and Colloidal Dispersions: Particle-Resolved Studies of Classical Liquids and Solids is the fifth and latest volume in a soft-condensed-matter series started by Pierre-Gilles de Gennes. Of the authors, Alexei Ivlev and Gregor Morfill are leaders in the study of complex plasmas, Patrick Royall is a colloid experimentalist specializing in imaging, and Hartmut Löwen is a theorist who covers a broad range of soft-matter topics.

The book emphasizes the use of plasmas and colloids to study fundamental phenomena, particularly nonequilibrium processes such as crystallization and glass formation, and the effects of external fields including gravity, electric and magnetic fields, and shear. Another motivation, which the book does not explicitly address, for studying the two systems is their practical importance. Dusty plasmas occur widely in the atmosphere and in space and are important in industrial processes such as computer-chip production. Colloidal dispersions are ubiquitous in everyday life, in such products as foods, paints, glues, cosmetics, and medicines.

After an introduction, chapters 2 and 3 deal with the basic properties of complex plasmas and colloidal dispersions: how the particles become charged and the nature of their interactions, including how external fields affect the interactions and other properties. Chapter 4 compares the two systems. For similar interactions, the structural arrangements of the particles in the two are the same, but the dynamics—that is, the particles’ thermal motion—are fundamentally different. In the dilute ionized gas of plasma, the particle motions are underdamped and obey simple Newtonian dynamics; in a dense liquid, the motions of colloidal particles are overdamped and are well described in terms of Langevin dynamics (or Brownian motion). These important differences are emphasized later in the book. Chapter 5 contains a description of the equipment used to study plasmas, a brief section on the preparation of colloids, and a survey of video microscopy and particle tracking.

The remaining two-thirds of the book covers various phenomena associated with both systems, under the headings Simple Liquids, Liquid-Solid Phase Transitions, Binary Mixtures, Slow Dynamics, Driven Systems, and Anisotropic Interactions. As is inevitable when covering a developing field, the narrative is not smooth. Some topics are treated in detail; in other cases the text simply notes the absence of a desirable experiment. The authors naturally emphasize their own interests and include some intensive theory sections.

The book convincingly makes the case that particle-resolved studies can provide information not obtainable in other ways. One example is the nature of the two-dimensional liquid–crystal freezing transition. Particle-resolved studies in both colloidal and plasma systems have elucidated the conditions under which freezing is a simple first-order transition, as in three dimensions, and those for which a more complex scenario applies—involving the appearance of an intermediate hexatic phase. Another complex and still not fully understood phenomenon that may be elucidated with particle-resolved studies is “laning”: Like pedestrians on a busy sidewalk, two species of particles pushed in opposite directions tend to form lanes from an initially disordered state.

The stated aim of the book series is to address “graduate students and junior researchers as an introduction to new fields, but it should also be useful to experienced people who want to obtain a general idea on a certain topic or may consider a change of their field of research.” In those aims I think the authors have been successful. Complex Plasmas and Colloidal Dispersions is not a textbook, although if supplemented by background reading, it could provide topics for an interesting graduate course. It is also not among the growing number of books that provide broad surveys of soft matter—the text is more focused than that. But, in part because of the extensive list of references, this book will certainly find a place on the shelves of experienced researchers as an up-to-date snapshot of a fast-developing area.

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