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Preface

Computational plasma physics

Plasma physics is blossoming and flourishing. It is a very fertile research area, from both a scientific and technological point of view. It sheds light on various astro- and geophysical phenomena: cosmic jets, solar flares, lightning bolts, and so on. Examples of plasma technology are, besides the classical example of discharge lamps: sterilisation, plasma medicines, removal of odour or NO_x, etching, boundary-layer control, and controlled nuclear fusion; a list that is still far from complete.

Given the often very high temperatures and short life times of plasma states, in general, computational plasma physics is a powerful alternative for experimental plasma research. A challenge of computational plasma physics is the development and exploitation of ever more realistic computational tools. Perfect realism by direct (brute-force) computer simulation of plasmas is impossible though in most instances, and will remain to be so for a long time, if not forever. With increasingly realistic resolution, multiscaledness increases, both temporally and spatially; a fundamental inhibitor for direct simulation. Although multiscale modelling has always been part and parcel of physics (think of approximating a body by a point mass, or the continuum hypothesis approximation in fluid dynamics), computational plasma physics has brought renewed interest in it; it has opened new perspectives and challenges.

Numerical mathematics is at computational physics' heart. With the increasing realism and hence complexity in computational plasma physics, numerical robustness and numerical efficiency are properties of growing importance. Baby-sitting complex plasma simulations because of the use of non-robust numerical techniques, is unwanted. And so is long-term occupation of fast and large computers by the use of inefficient numerical methods. Numerical mathematics is found throughout this entire issue, like oxygen in the earth's atmosphere; from low to high density, often imperceptible but always indispensable. This special issue is intended for readers who are interested in computational plasma physics in general though, not specifically in its numerics. In composing the issue, we have also been open to papers that are oriented towards modelling and analysis rather than to computing.

The following application areas are addressed in the special issue: (i) nuclear fusion in deuterium–tritium plasmas (five papers on magnetically and one on inertially confined plasmas), (ii) electrical discharges (four papers), (iii) astrophysics (three papers) and (iv) space weather (two papers).

We thank all people who have helped us in preparing this special issue: the reviewers, the editor-in-chief and technical editors of the Journal of Computational Physics, and most of all the authors. We wish you fruitful and pleasant reading.

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