Computational Physics

(using C++)

Konstantinos N. Anagnostopoulos

This book is an introduction to the computational methods used in physics, but also in other scientific fields. It is addressed to an audience that has already been exposed to the introductory level of college physics, usually taught during the first two years of an undergraduate program in science and engineering. It assumes no prior knowledge of numerical analysis, programming or computers and teaches whatever is necessary for the solution of the problems addressed in the text. C++ is used for programming the core programs and data analysis is performed using the powerful tools of the GNU/Linux environment. All the necessary software is open source and freely available.

The book starts with very simple problems in particle motion and ends with an in-depth discussion of advanced techniques used in Monte Carlo simulations in statistical mechanics. The level of instruction rises slowly, while discussing problems like the diffusion equation, electrostatics on the plane, quantum mechanics and random walks. The book aims to provide the students with the background and the experience needed in order to advance to high performance computing projects in science and engineering. It puts emphasis on hands–on programming of numerical code but also on the production, analysis and interpretation of data. But it also tries to keep the students motivated by considering interesting applications in physics, like chaos, quantum mechanics, special relativity and the physics of phase transitions.
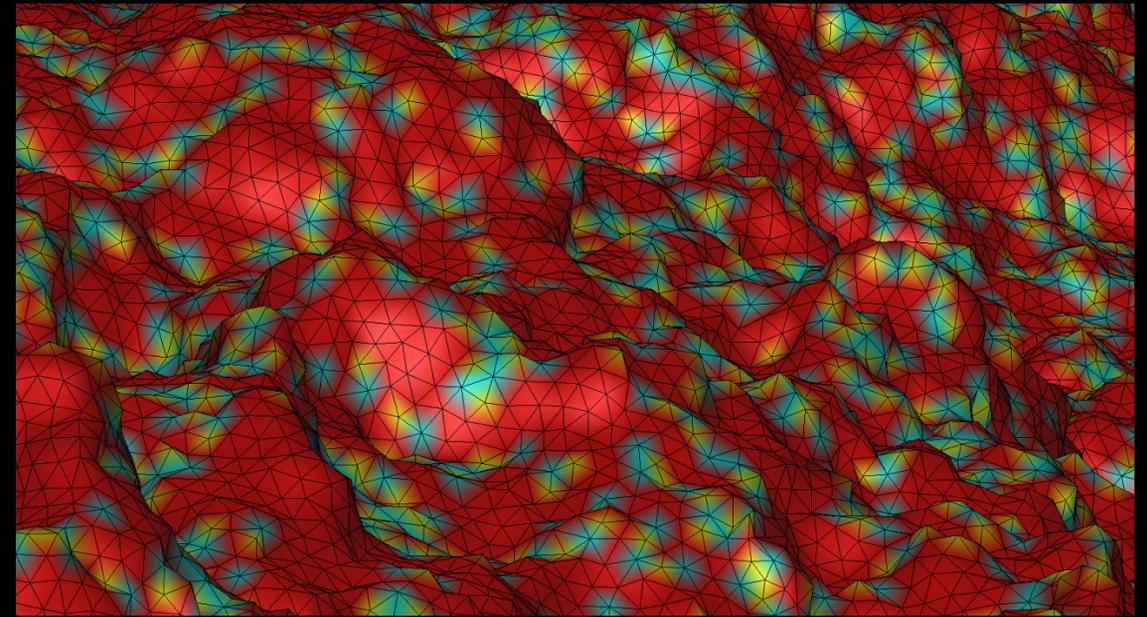
Konstantinos Anagnostopoulos was educated at the University of Athens and at Syracuse University where he obtained his Ph.D. in theoretical physics in 1993. He has been a researcher at the Institute for Fundamental Theory at the University of Florida, Gainesville and at the Niels Bohr Institute at the University of Copenhagen from 1993 to 1999. He held a visiting professor position at the University of Crete from 1999-2004, and in 2004 he moved to Athens where he has been a member of the faculty of the Physics Department of the National Technical University of Athens (NTUA) ever since. His area of expertise is computational physics with an emphasis in theoretical high energy physics, string theory and quantum gravity. He is a world expert in Monte Carlo simulations of such systems, and he has participated in projects run onto the world's largest supercomputers. At NTUA he founded three undergraduate computational physics and scientific computing courses at the senior and sophomore level, which he has been teaching since 2004. The audience of those courses are students interested in theoretical physics, but also students majoring in a wider area of applied mathematics, physics and engineering.

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