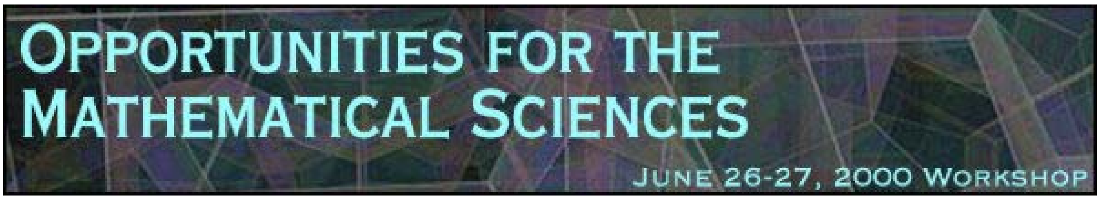

Computations and Numerical Simulation

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The area of computation in general, and numerical simulation in particular, has made spectacular advances in the past; it is an area which attracts a growing number of researchers and where further advances are greatly needed and can be expected. The use of numerical computations in industry and scientific research has increased tremendously in the past several decades. Industries, such as the electronic, aerospace, petroleum, and pharmaceutical industries, now use numerical simulation extensively as an integral part of their design process. Researchers, both in the physical and life sciences, now use simulation to the extent that some talk about computation as the third paradigm of science, along with theory and experimentation.

The combined advances in several disciplines have contributed to our increasing ability to use numerical computations: the increased speed of the hardware and the concurrent decrease in its cost, advances in computer science which have provided us with the tools to more easily express the computations which have to be performed and the graphical output to see and interpret the results, and new mathematical algorithms which enable us to solve problems that even the increased speed of the hardware alone would have left beyond our reach.

The goal of much of the research in numerical algorithms is the development of algorithms that are faster to execute and/or increase the accuracy of the results. Even a partial list of the advances indicates the recent contributions of mathematics to our ability to widely use computational methods in science and technology: finite element method, multi-grid method, fast multi-pole algorithm, semi-automatic grid generation, and libraries, such as LINPAC and LAPAC, which relieve the user of the need to write fast and accurate basic linear algebra subroutines.

But even with all these advances there is much to be done. Quite often we have to simplify the equations, smooth the geometries, and introduce symmetries in order to make the problem computationally solvable; within industry it is often that it takes weeks, or even months, to set up the mesh while the actual computation time is measured in minutes or hours. Thus, if the vision, and expectation, of the benefits of computations to science and engineering are to materialize, we need even better tools than what are available today: we need faster computers; we need better and more convenient ways to express the problems and the graphics to visualize the results; but most of all we need better mathematical algorithms--better ways to generate the meshes, faster and more accurate ways to integrate the equations, and higher level subroutines to aid in the solution of the specific problems.

Can we expect the mathematical sciences research community to make the necessary advances? I believe that the answer is affirmative. The steady progress and the solid achievements of the past several decades, and the number of young researchers who are attracted to this area give rise to this optimism. In the past few years researchers started to talk about the body of knowledge regarding numerical computations, and the research issues to be tackled, as a new discipline that they call Computational Science--a discipline that encompasses parts of mathematics, computer science, and the applications in science and engineering. Whether or not Computational Science is indeed a discipline, this naming indicates the pride of researchers in computations and numerical simulations in their past scientific achievements, their pride in the impact on other scientific and engineering areas, and their confidence in future achievements and a greater impact. I believe that this confidence is fully justified.

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