Electronic Transactions on Numerical Analysis.
Volume 6, pp. 1-34, December 1997.

ISSN 1068-9613.

ETNA
Kent State University
etna@mcs.kent.edu

THE GAUSS CENTER RESEARCH IN MULTISCALE SCIENTIFIC COMPUTATION*

ACHI BRANDT†

Abstract. The recent research of the author and his collaborators on multiscale computational methods is reported, emphasizing main ideas and inter-relations between various fields, and listing the relevant bibliography. The reported areas include: top-efficiency multigrid methods in fluid dynamics; atmospheric data assimilation; PDE solvers on unbounded domains; wave/ray methods for highly indefinite equations; many-eigenfunction problems and ab-initio quantum chemistry; fast evaluation of integral transforms on adaptive grids; multigrid Dirac solvers; fast inverse-matrix and determinant updates; multiscale Monte-Carlo methods in statistical physics; molecular mechanics (including fast force summation, fast macromolecular energy minimization, Monte-Carlo methods at equilibrium and the combination of small-scale equilibrium with large-scale dynamics); image processing (edge detection and segmentation); and tomography.

Key words. Scientific computation, multiscale, multi-resolution, multigrid, fluid dynamics, atmospheric flows, data assimilation, wave problems, Dirac equations, inverse matrix, Schrödinger operator, Monte-Carlo algorithms, critical slowing down, molecular mechanics, fast force summation, energy minimization, integro-differential equations, tomography, image processing, edge detection, segmentation

AMS subject classifications. 34A50, 35A40, 44–04, 45–04, 65C05, 65F10, 65F15, 65F40, 65K10, 65M30, 65M50, 65M55,65N22, 65N25, 65N38, 65N55, 65R10, 65R20, 65Y05, 68U10, 70-08, 76-04, 76M20, 81-08, 81T80, 82-08, 82B80, 82C80, 92E99

---

* Received May 17, 1997. Accepted October 17, 1997. Communicated by C. Douglas. This research was supported by grants No. G0289-065.07/93 from the German-Israeli Foundation for Research and Development (GIF), No. 379/93 from the Israeli Academy of Science and Humanities, and No. NAG 1 1823 from NASA; by grants from the U.S. Air Force Office of Scientific Research and the Material and Manufacturing Directorate of the Air Force Research Laboratory; and by the Carl F. Gauss Minerva Center for Scientific Computation at the Weizmann Institute of Science.

† Weizmann Institute of Science, Rehovot 76100, Israel