

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