Session Dedicated to the Memory of Moshe Israeli (1940-2007)

Contributions of Prof. Moshe Israeli to Scientific Computing

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Prof. Moshe Israeli and I have had strong collaborative relationships from 1986 until his sudden death on February 2007. This fruitful collaboration touches various fields related to scientific computing such as: parallel processing, asynchronous computation, domain decomposition methods for solving parabolic PDEs on multiprocessors, domain decomposition methods with local Fourier basis for parabolic problems, spectral multidomain techniques, parallel solutions of the Navier-Stokes equations, Poisson solvers (2D, 3D), time dependent diffusion equations with variable coefficients using multiwavelets, Helmholtz solvers, oscillatory integrals, material sciences, wavelet and multiresolution analysis, image processing, Integral transforms in pseudo- and polar grid including the Radon transform, modeling of nano-batteries.

I will give a short description of these areas and their contributions to scientific computing and I will concentrate on one of our latest works:

Irregular Sampling for Multidimensional Polar Processing of Integral Transforms

We describe a family of theories that enable to process polar data via integral transforms. We show the relation between irregular sampling and discrete integral transforms, demonstrate the application of irregular (polar) sampling to image processing problems, and derive approximation algorithms that are based on unequally spaced samples. It is based on sampling the Fourier domain. We describe 2D and 3D irregular sampling geometries of the frequency domain, derive efficient numerical algorithms that implement them, prove their correctness, and provide theory and algorithms that invert them. We also show that these sampling geometries are closely related to discrete integral transforms. The proposed underlying methodology bridges via sampling between the continuous nature of the physical phenomena and the discrete nature world. Despite the fact that irregular sampling is situated in the core of many scientific applications, there are very few efficient numerical tools that allow robust processing of irregularly sampled data.

Joint works with R. Coifman, D. Donoho, Y. Shkolnisky.

Automated Transformations of PDE Systems

Irad Yavneh
Department of Computer Science
Technion

We study an approach for transforming systems of partial differential equations (PDE) in order to obtain new formulations, especially decoupled ones that are more accessible to numerical solution. An algorithm is developed for generating such transformations automatically, using symbolic manipulations employing Groebner bases. The algorithm is implemented using freely available symbolic software. This approach, along with planned developments, will potentially provide a powerful set of tools for handling large systems of partial differential equations.

Joint work with Shmuel Onn Yossi Gil and Zvika Gutterman

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Clustering Phenomena for Particulate Flow in Spinning Cylinders

Roland Glowinski,
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The main goal of this lecture is to present the result of numerical experiments addressing the direct numerical simulation of particle clustering phenomena taking place in a rotating cylinder containing a fluid-particle mixture, when the spinning angular velocity is large enough. After a brief description of the computational methodology used for these simulations, we will present movies showing how the spinning angular velocity influences the way particles clusters. A snapshot visualizing the transition to well separated clusters is shown on the figure below. This lecture is relevant to a mini-symposium dedicated to Moshe Israeli since: (i) The fluid component of the mixture is an incompressible viscous fluid whose flow is modeled by the Navier-Stokes equations. (ii) Laboratory experiments exhibiting this clustering phenomenon have been performed in the Chemical Engineering Department of the Israel Institute of Technology in Haiffa, the institution where our regretted colleague spent most of his very distinguished career.

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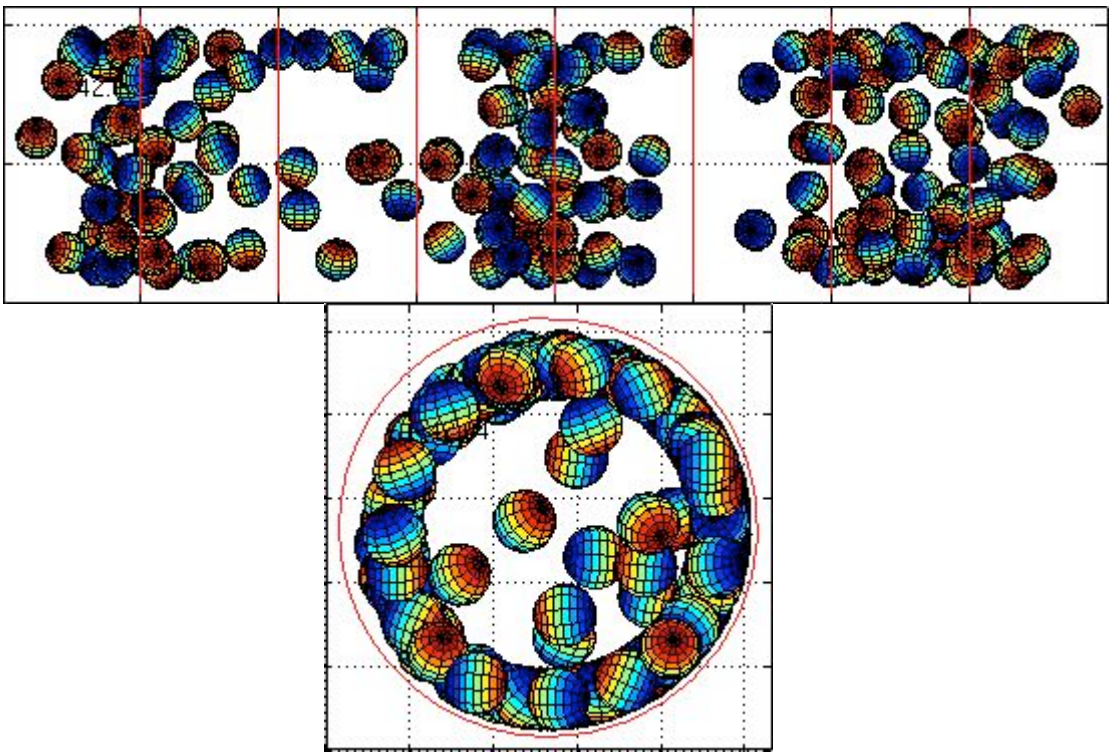

Visualizations of the clustering phenomenon