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INTEGRAL EQUATIONS AND INVERSE BOUNDARY VALUE PROBLEMS

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Given the success of applying integral equations to direct boundary value problems both for the theoretical foundation and the numerical solution, it is no surprise that integral equations also play an important role in the analysis of the corresponding inverse problems. This special issue will cover recent developments in the use of integral equations for solving inverse boundary value problems arising from nondestructive evaluation using electro- and magnetostatic imaging and time-harmonic acoustic and electromagnetic wave scattering, i.e., inverse boundary value problems for the Laplace, Helmholtz and Maxwell equations. We expect the readership to consist of researchers and students interested in merging integral equations and inverse problems.

Roughly speaking, the methods for solving inverse boundary value problems can be classified into three groups. Iterative methods interpret the inverse boundary value problem as a nonlinear ill-posed operator equation and apply iterative schemes such as regularized Newton methods, Landweber iterations or conjugate gradient methods for its solution. Decomposition methods, in principle, separate the inverse boundary value problem into an ill-posed linear problem to reconstruct the solution of the partial differential equation from partial knowledge on it followed by a nonlinear problem that determines the boundary shape from the boundary condition. Finally, the third group consists of the more recently developed sampling and probe methods. These are based on indicator functions formulated in terms of solvability conditions for ill-posed linear integral equations that decide whether a point lies inside or outside the unknown object. For each of these three groups, this special issue contains two papers with the majority of them devoted to scattering theory.

Starting with iterative methods, the paper by H. Harbrecht and T. Hohage is concerned with the numerical solution of the inverse obstacle scattering problem to reconstruct the shape of a three dimensional sound-soft scatterer from the far field pattern of the scattered wave for scattering of plane waves. Their method is a regularized Newton