Workshop on

Numerical Methods for Fully Nonlinear and Related PDEs

at the Mathematisches Forschungsinstitut Oberwolfach (MFO)

Abstract

The construction, implementation, and analysis of computational methods for nonlinear partial differential equations (PDEs) are critical for the resolution of many scientific and engineering problems because they are the governing equations for these problems. Among them fully nonlinear second order PDEs are relatively new, yet critical research areas in numerical analysis and scientific computing. Such problems arise in many application areas including meteorology, cosmology, geometric optics, differential geometry, optimal transport, economics, image processing and mesh generation. These problems constitute one of the most difficult classes of PDEs to approximate numerically, and breakthroughs in their discretization have only appeared within the last ten years. While there have been several advances in numerical fully nonlinear second order PDEs, there still remain fundamental challenges that need to be addressed properly. Examples include a priori error estimates for non–smooth generalized solutions, robust numerical methods for general families of problems, imposition of non–standard boundary conditions, and fast solvers of the resulting nonlinear algebraic systems. In addition, certain related quasilinear PDEs, although not fully nonlinear, from material science, nonlinear elasticity and image processing also pose significant difficulties to develop efficient and robust numerical methods because of their peculiar structures and nonsmooth solutions. This workshop intends to create a forum for junior and senior researchers to discuss the challenges of numerical approximations of fully nonlinear second order PDEs and related quasilinear PDEs with nonsmooth solutions, and to disseminate recent advances on numerical methods for those nonlinear PDEs and their applications.