Electro-Optics & Mathematics Joint Seminar
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Symbolic Computation of Conservation Laws of Nonlinear Partial Differential Equations

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Abstract

A method will be presented for the symbolic computation of conservation laws of nonlinear partial differential equations (PDEs) involving multiple space variables and time. Using the scaling symmetries of the PDE, the conserved densities are constructed as linear combinations of scaling homogeneous terms with undetermined coefficients. The variational derivative is used to compute the undetermined coefficients. The homotopy operator is used to invert the divergence operator, leading to the analytic expression of the flux vector. The method is algorithmic and has been implemented in the syntax of the computer algebra system Mathematica. The software is being used to compute conservation laws of nonlinear PDEs occurring in the applied sciences and engineering. The software package will be demonstrated for PDEs that model shallow water waves, ion-acoustic waves in plasmas, sound waves in nonlinear media, and transonic gas flow. The featured equations include the Korteweg-deVries, Kadomtsev-Petviashvili, Zakharov-Kuznetsov, and Khoklov-Zabolotskaya equations.

Biographical sketch

Dr. Willy Hereman is Professor and Chair of Mathematical and Computer Sciences at the Colorado School of Mines. He received his BS, MS and PhD in Applied Mathematics from the University of Ghent, Belgium, in 1974, 1976 and 1982, respectively. Prior to the School of Mines, he was with the ECE department at the University of Iowa under a NATO Research Fellowship, and with the Mathematics department at the University of Wisconsin as a Visiting Assistant Professor. He has published over 100 research papers in acousto-optics, scattering theory, soliton theory, nonlinear wave phenomena, wavelets, and symbolic methods for nonlinear partial differential equations and lattices. His work has been mainly supported by the NSF. He is a laureate of the Royal Academy of Sciences of Belgium and a member of several professional organizations including ASEE, AMS, and SIAM.