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Preface

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Professor Xu-Dong Liu

Xu-Dong Liu, in his tragically abbreviated career, made many significant contributions to scientific computing. These include: (in order of the number of citations on Google scholar) (1) The invention of weighted essentially nonoscillatory (WENO) schemes (2) A third order nonoscillatory

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scheme (3) A boundary condition capturing method (for both Poisson's equation and multiphase incompressible flow) (4) Positive schemes and applications (5) Convex ENO high order schemes without field-by-field decomposition (6) Maximum principle satisfying triangle based schemes. (7) The ghost fluid method for viscous flows and elliptic equations (with a convergence proof).

This is an excellent record. Xu-Dong was at the height of his powers when he became ill. We will never know what other important contributions he would have made. This issue, for example, contains an interesting paper by Xu-Dong and Song Ming Hou in a new field for Liu - namely discontinuous Galerkin methods.

Now for a description of some of his work:

Essentially nonoscillatory (ENO) schemes, invented in the late 1980's, provided a framework for reducing spurious oscillations in shock capturing methods. These oscillations typically occur near discontinuities when high accuracy is desired. The original idea was to choose an interpolant in a nonlinear and local fashion by taking information from the direction in which the solution is smoothest. This decision is a bit extreme, and Xu-Dong's contribution (with Osher and Chan) was to take a convex combination of the possible discrete directions, also based on smoothness. This provides us with the possibility of high accuracy in smooth regions, even for relatively narrow stencils. Typing in WENO schemes on Google gives approximately 50,000 responses. These have become the method of choice for many shock capturing and Hamilton-Jacobi solvers.

Central schemes for conservation laws have the advantage that costly field-by-field decompositions are avoided. Liu and Tadmor devised a third order Godunov type scheme which works well and has a solid theoretical foundation. Later, with Osher, Xu-Dong devised a new convex ENO procedure which also avoids field-by-field decompositions, is of arbitrary order, and seems to work quite well, at least up to and including third order.

Interfaces have a variety of jump conditions that need to be satisfied. The Ghost Fluid Method (GFM) was developed to capture these originally for a contact discontinuity in the inviscid compressible Euler-equations. Liu, with R.P. Fedkiw, and M. Kang extended this idea nicely to Poisson's equation, multiphase incompressible flow and viscous flows. Also, with T.C. Sideris, Liu proved convergence for second order elliptic equations. GFM has proven to be quite successful (12,500 hits on Google) and Liu's contributions are significant.

In a series of papers with P.D. Lax, Xu-Dong extended K.-O. Friedrichs' positivity criteria devised for linear symmetric hyperbolic systems, to symmetrizable systems of nonlinear conservation laws. This design principle for approximations to conservation laws seems to give good performance for an interesting class of applications, including two dimensional Riemann problems for gas dynamics.

We mourn the loss of a special person, a talented scientist, a loving father and husband, an interactive colleague and our wonderful friend.