Eitan TADMOR – Career Narrative

Eitan Tadmor is a Distinguished University Professor at the University of Maryland (UMd), College Park. He began his scientific career in 1980 as a Bateman Research Instructor in CalTech. He later chaired the Department of Applied Mathematics in his alma mater, Tel-Aviv University 1991–1993. In 1995 Tadmor was recruited by the UCLA Department of Mathematics where he was the Founding Co-Director of the NSF Institute for Pure and Applied Mathematics (IPAM), 1999–2001. He moved to UMd in 2002, and served as the Director of the University Center for Scientific Computation and Mathematical Modeling (CSCAMM), 2002–2016.

Synergetic activities include co-chairing International Conferences on Hyperbolic Problems, hosted at CalTech (Hyp2002) and at UMd (Hyp2008), and serving on numerous Scientific Committees, including the Abel Symposium on "Nonlinear PDEs" held in Oslo, 2010. Tadmor was the Principal Investigator (PI) for an NSF Focus Research Group on "Kinetic Description of Multiscale Phenomena" (2008–2012). In 2012 he was the PI awarded the NSF Research network "Kinetic Description of Emerging Challenges in Natural Sciences" (Ki-Net) and is currently serving as the Ki-Net Director (2012–2020).

Tadmor was a senior fellow at the Institute for Theoretical Studies (ITS), ETH-Zurich, 2016-2017. He also held numerous visiting positions, including longer visits at the universities of Michigan, Brown, the Courant Institute, the Weizmann Institute and at the Sorbonne (LJLL). He serves/served on the editorial boards of more than a dozen leading journals including European Math Surveys in Math. Sci. (2014–), Acta Numerica (2009–), SIAM J. Math. Analysis (2004–), J. Foundations of Computational Math. (2004–) and SIAM J. on Numerical Analysis (1990–2013). Notable addresses include an invited lecture at the 2002 ICM (Beijing), plenary addresses in the international conferences on hyperbolic problems (Zürich 1990 and Beijing 1998), the 2014 SIAM invited address at the Joint Mathematical Meeting (JMM) in Baltimore, the 2016 Leçons Jacques-Louis Lions at UPMC, Sorbonne University and invited lecture at the 2019 ICIAM (Valencia).

Tadmor was listed on the 2003 ISI most cited researchers in Mathematics. In 2012 he was in the inaugural class of Fellows of the American Mathematical Society. In 2015 he was awarded the SIAM-ETH Henrici prize for "*original, broad and fundamental contributions to the applied and numerical analysis of nonlinear differential equations and their applications ...*".

The signature of Tadmor's work is the interplay between analytical theories and computational algorithms with diverse applications to shock waves, kinetic transport, incompressible flows, image processing, and self-organized collective dynamics. In particular, he has made a series of fundamental contributions to the development of high-resolution methods for nonlinear conservation laws, introducing the classes of *central schemes*, *entropy conservative/stable schemes* and *spectral viscosity methods*. He has carried out ground-breaking work on the rigorous derivation of transport models and their relation to *kinetic theories*, co-authored with P.-L. Lions, B. Perthame (1994) and T. Tao (2002), and a separate line of work on *critical thresholds phenomena* in such models. He introduced novel ideas of multi-scale *hierarchical decompositions* of images and solutions of PDEs in critical regularity spaces. He leads an interdisciplinary research program in modeling and analysis of *social (hydro-)dynamics* with applications to flocking and opinion dynamics.

Eitan TADMOR – 10 principal Publications

1 Convergence of spectral methods for nonlinear conservation laws, *SINUM 26 (1989) 30–44*

This paper introduced the Spectral Viscosity method — the first systematic method to treat shock discontinuities with spectral calculations. A follow-up a large body of related works.

2 Non-oscillatory central differencing for hyperbolic conservation laws
(with H. Nessyahu), *J. of Computational Physics 87 (1990) 408–463*

This paper introduced the Nessyahu-Tadmor scheme — the forerunner for the class of high-resolution "central schemes", and led to a large number of publications on related black-box solvers for a wide variety of problems governed by multi-dimensional systems of non-linear conservation laws and related PDEs.

3 Local error estimates for discontinuous solutions of nonlinear hyperbolic equations
SIAM J. Numerical Anal. 28 (1991) 891–906

This paper introduced a novel convergence rate theory for nonlinear conservation laws and related Hamilton-Jacobi equations that led to optimal L^1-convergence rates.

4 A kinetic formulation of multidimensional scalar conservation laws and related equations
(with P.-L. Lions & B. Perthame) *J. Amer. Math. Soc. 7 (1994) 169–191*
and a follow-up work
Velocity averaging, kinetic formulations and regularizing effects in quasi-linear PDEs
(with Terence Tao) *Communications Pure & Applied Math. 60 (2007), 1488–1521*

These papers provide the systematic treatment of kinetic formulation of entropic solutions for nonlinear conservation laws and related convection-diffusion equations and derivation of novel regularizing results.

5 High order time discretization methods with the strong stability property
(with S. Gottlieb and C.-W. Shu), *SIAM Review 43 (2001) 89–112*

This is the standard reference for Strong Stability Persevering (SSP) numerical solvers of ODEs.

6 Entropy stability theory for difference approximations of nonlinear conservation laws and related time dependent problems, *Acta Numerica 12 (2003), 451–512*

Here we introduced a novel family of entropy conservative schemes and provides a general framework for studying entropy stability of difference approximations for nonlinear systems of conservation laws by comparison.

7 A multiscale image representation using hierarchical (BV,L^2) decompositions
(with S. Nezzar and L. Vese) *Multiscale Modeling & Simulation 2 (2004) 554–579*

We introduce a novel hierarchical decomposition of images and solutions of equations in critical regularity spaces into multi-scale components.

8 A new model for self-organized dynamics and its flocking behavior
(with S. Motsch), *J. Stat. Physics 144(5) (2011) 923–947*

Introduced a new model for far from equilibrium self-organized dynamics based on relative distances.

9 ENO reconstruction and ENO interpolation are stable
(with U. Fjordholm and S. Mishra) *Foundations Computational Math. 13(2) (2012), 139–159*

First stability proof for the ENO reconstruction, indicating a remarkable rigidity for ENO procedure of arbitrary order of accuracy and on non-uniform meshes.

10 Topologically-based fractional diffusion and emergent dynamics with short-range interactions
(with R. Shvydkoy) *SIAM J. Math. Anal. in press, ArXiv:1806:01371v4)*

Introduce a new class of models for emergent dynamics based on a new communication protocol which incorporates short-range kernels adapted to the local density which form *topological neighborhoods*. We prove flocking behavior and (global) regularity via an application of a De Giorgi-type method.