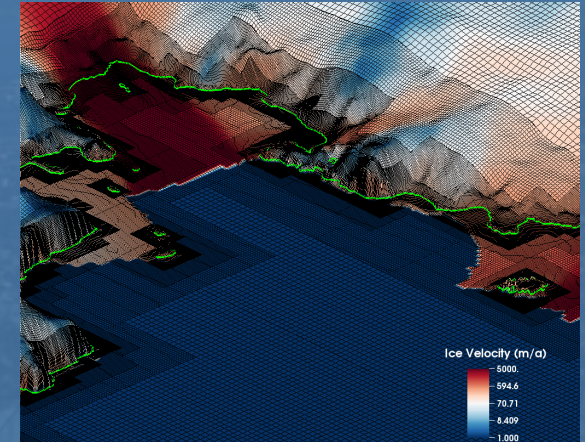


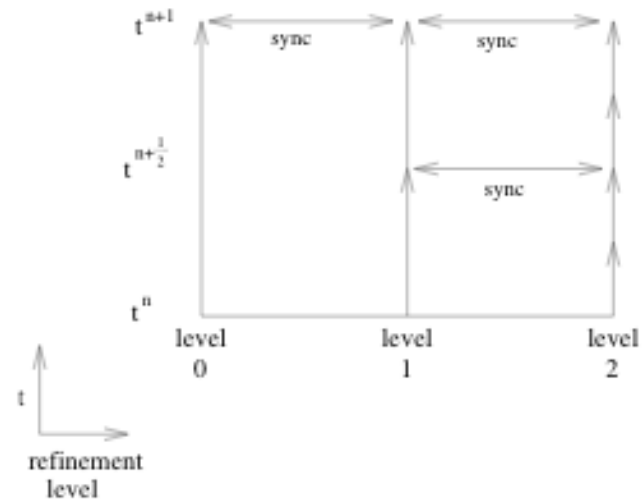
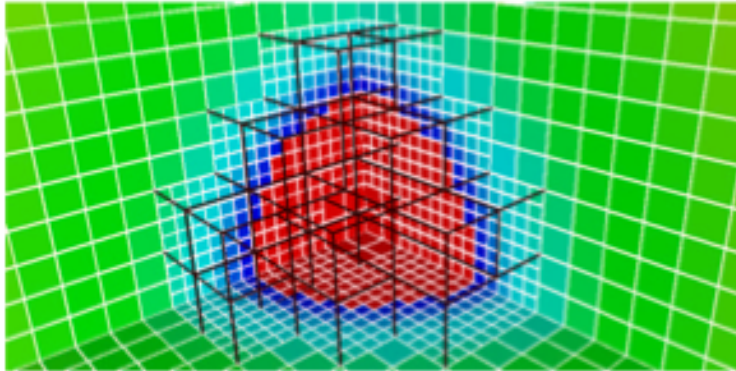
## Adaptive Mesh Refinement

Phillip Colella

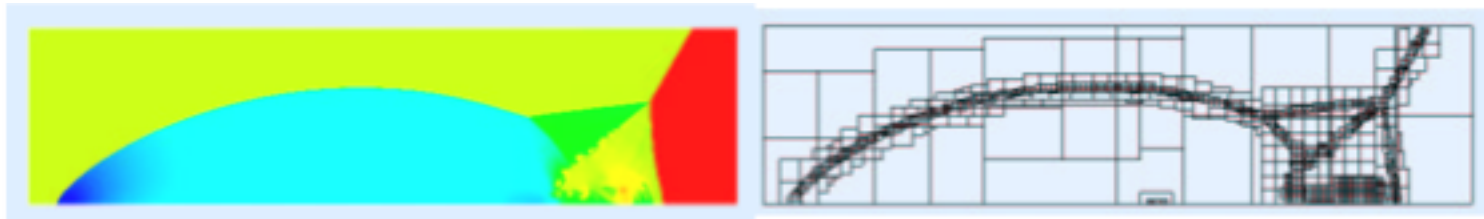
Lawrence Berkeley National Laboratory



# What is Adaptive Mesh Refinement ?



Refined regions are organized into rectangular patches.  
Refinement performed in time as well as in space.



- Berger, 1982 Ph.D. thesis; Berger and Olinger, 1984.
- Berger and Colella, 1989 – practical algorithm for unsteady fluid dynamics problems.

# Built on a foundation from DOE Applied Mathematics

- Mathematical analysis of applied nonlinear PDE: well-posedness, locality, local regularity.
- Finite-volume methods for conservation laws.
- Analysis of multiphysics problems.

APPROVED FOR PUBLIC RELEASE

UNCLASSIFIED

LOS ALAMOS SCIENTIFIC LABORATORY  
of the  
UNIVERSITY OF CALIFORNIA

PUBLICLY RELEASABLE  
LANL Classification Group  
*Michael Young 9/20/94*

Report written:  
December 1952  
Report distributed: FEB 18 1953

LAMS-1332

ON DISCONTINUOUS INITIAL VALUE PROBLEMS FOR NONLINEAR EQUATIONS  
AND FINITE DIFFERENCE SCHEMES

Work done by:  
Peter Lax  
Lester Baumhoff

Report written by:  
Peter Lax

VERIFIED UNCLASSIFIED  
*NLM 6/18/79*

All Los Alamos reports present the opinions of the author or authors and do not necessarily reflect the views of the Los Alamos Scientific Laboratory. Furthermore, this LAMS report has not been prepared for general distribution. It is accordingly requested that no distribution be made without the permission of the Director's Office of the Laboratory.

PHYSICS

UNCLASSIFIED

APPROVED FOR PUBLIC RELEASE

3 9338 00424 7007



COMPUTATIONAL  
RESEARCH  
DIVISION



# Collaboration between mathematics and computer science.

- Data structures beyond rectangular arrays.
- HPC on vector computers, distributed memory multiprocessors.
- Use of modern software technologies (C++ frameworks that look like embedded DSLs).
- Other innovative techniques, e.g. edge detection algorithms for grid generation (Berger and Rigoutsos), cut-cell grid generation using adaptive precision arithmetic (Aftosmis, Berger, and Melton).

# Developed hand-in-hand with scientific applications

- Shock physics.
- Low-Mach number combustion.
- Astrophysics.
- Aerodynamics.
- Subsurface flows.
- Plasma physics.
- ...

# Growth of a community

Figure 3.1. The Berger-Colella-Bell Stream of AMR Development

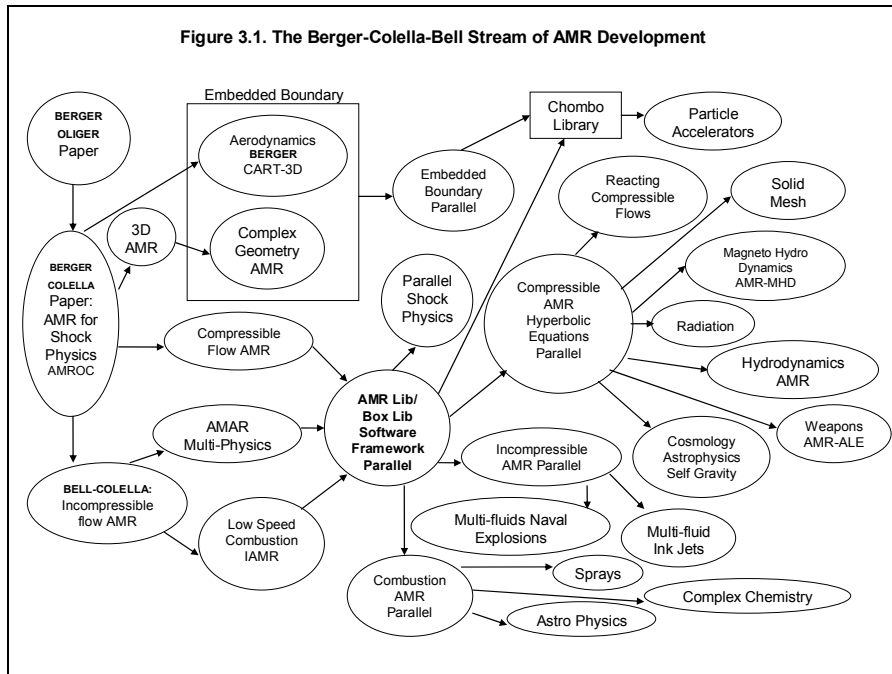
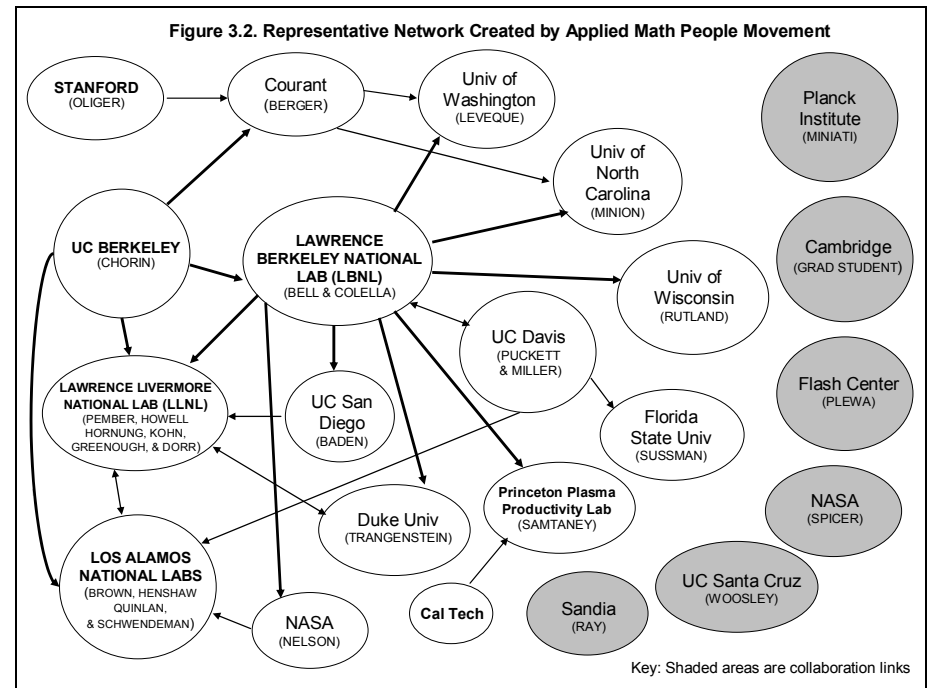


Figure 3.2. Representative Network Created by Applied Math People Movement



From a report to the DOE Office of Science by S. Mohrman and J. Galbraith, USC Marshall School of Business, 2005

# Keys to Success

- A broadly-applicable technology being developed in tandem with specific difficult science problems being solved.
- Long-term support.
- Engagement with visionary science partners.
- Flexibility about bureaucratic boundaries.