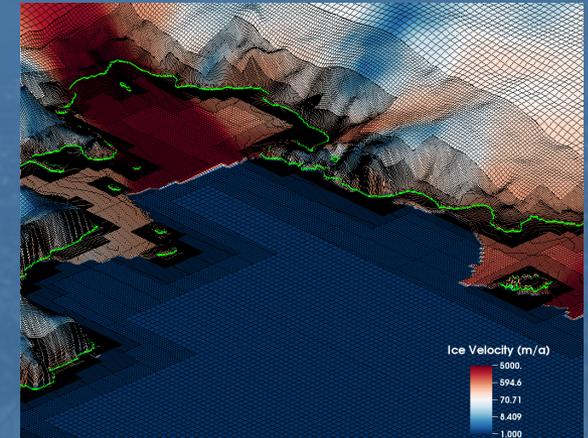


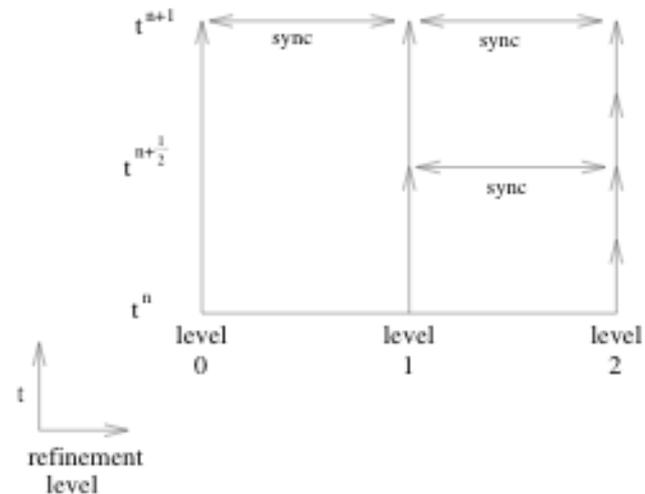
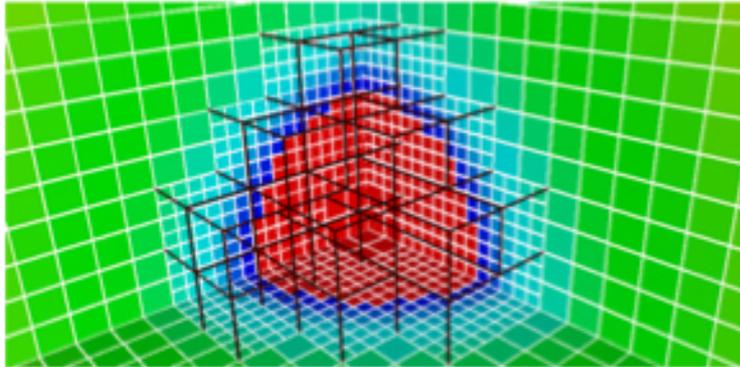
## Adaptive Mesh Refinement

Phillip Colella

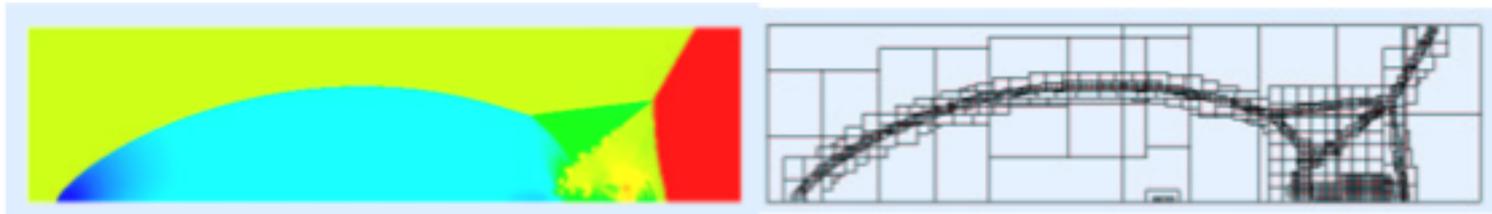
Lawrence Berkeley National Laboratory



# 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.

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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*

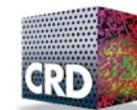
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COMPUTATIONAL  
RESEARCH  
DIVISION



# 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

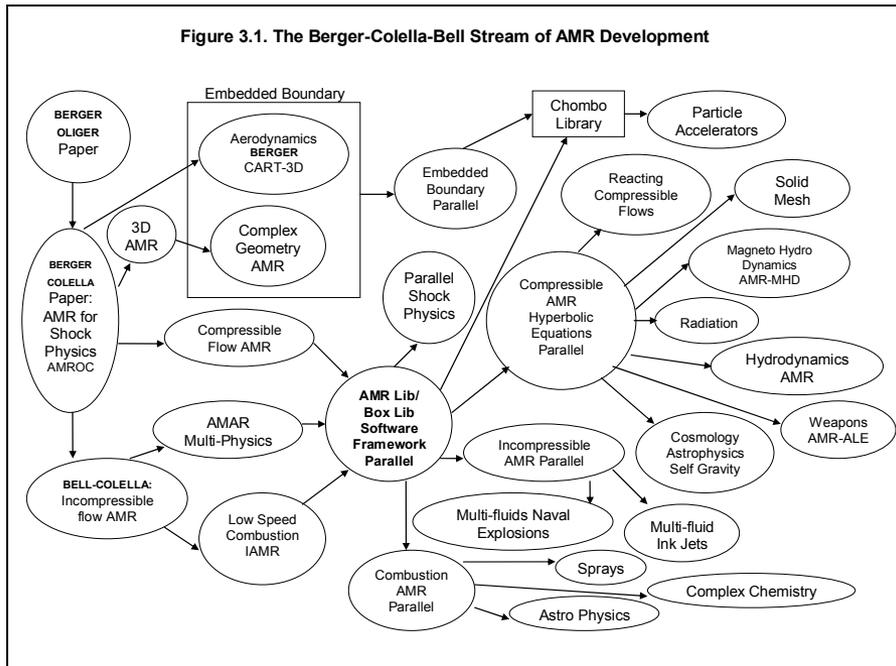
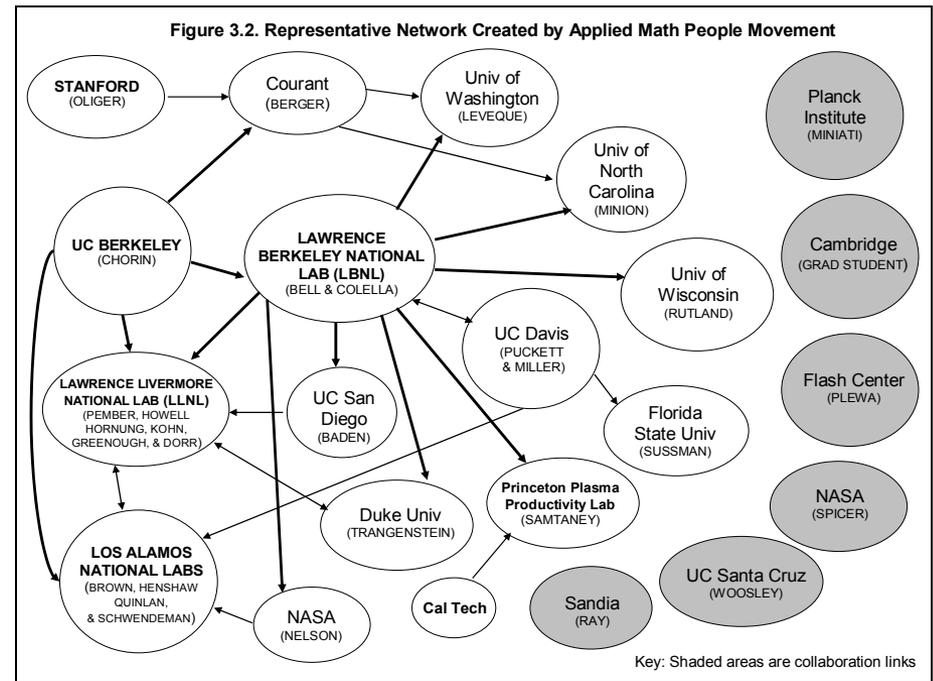


Figure 3.2. Representative Network Created by Applied Math People Movement



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.