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Numerical Algorithms for Compressible Turbulence

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This research involves higher order methods for solving partial differential equations. A common theme of this research is the use of spectral methods. One of the challenges of the spectral Fourier method is approximating smooth functions that are non-periodic. The rate of convergence deteriorates to $O(\frac{1}{N})$ away from the boundaries and there are spurious oscillations at the boundary points, known as the *Gibbs phenomenon.*

We discuss an analytic but non-periodic function $f(x)$ defined on $[-1,1]$, for which the first $2N+1$ Fourier coefficients are known, and focuses on two methods that successfully eliminate the Gibbs phenomenon based on the information obtained from the Fourier coefficients. A new method is suggested to improve upon the results that have been obtained thus far.

Also discussed is the Gibbs phenomenon for spherical harmonic spectral methods applied to functions that are piecewise analytic on spheres. We prove that knowledge of the first N spherical harmonic coefficients yield an *exponentially convergent* approximation to a spherical piecewise smooth function, hence completely overcoming the Gibbs phenomenon.

Higher order numerical methods are applied to a specific one-dimensional hyperbolic system that describes the shallow water dynamics of a linearly sloping gulf. This problem is challenging due to the constantly changing location of where the water touches the shore. At this point the equation loses its strong hyperbolicity, and conventional numerical methods may not produce the correct solution. Also, any discontinuities that may arise as a result of the nonlinearity cannot be predicted, and this must be considered in selecting a numerical method.

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FORM A2-2

AUGMENTATION AWARDS FOR SCIENCE & ENGINEERING RESEARCH TRAINING (AASERT) REPORTING FORM

The Department of Defense (DOD) requires certain information to evaluate the effectiveness of the AASERT program. By accepting this Grant Modification, which bestows the AASERT funds, the Grantee agrees to provide the information requested below to the Government's technical point of contact by each annual anniversary of the AASERT award date.

1. Grantee identification data: (R & T and Grant numbers found on Page 1 of Grant)

a. Brown University
University Name

b. N00014-93-1-0985
Grant Number

c. 4322601---01
R & T Number

d. David Gottlieb
P.I. Name

e. From: 7/93 To: 7/96
AASERT Reporting Period

NOTE: Grant to which AASERT award is attached is referred to hereafter as "Parent Agreement."

2. Total funding of the Parent Agreement and the number of full-time equivalent graduate students (FTEGS) supported by the Parent Agreement during the 12-month period **prior to** the AASERT award date.

a. Funding: $ 189,447

b. Number FTEGS: 1

3. Total funding of the Parent Agreement and the number of FTEGS supported by the Parent Agreement during the current 12-month reporting period.

a. Funding: $ 0

b. Number FTEGS: 0

4. Total AASERT funding and the number of FTEGS and undergraduate students (UGS) supported by AASERT funds during the current 12-month reporting period.

a. Funding: $ 101,921

b. Number FTEGS: 1

c. Number UGS: 0

VERIFICATION STATEMENT: I hereby verify that all students supported by the AASERT award are U.S. citizens.

Principal Investigator

Date