Conference
Program

Fourth International Conference on

Numerical

Combustion

December 2-4, 1991
TradeWinds Hotel ⊙ St. Petersburg Beach, Florida

Conference Themes
Asymptotics and Numerical Experiments
Complex Chemistry
Detonations and Detonation Stability
Drops and Sprays
Fires
Flame-Vortex Interaction
Ignition
Industrial Applications
Laminar Flames
Multiphase Combustion
New Numerical Methods
Supersonic Combustion
Turbulence

Sponsored by SIAM with the cooperation of INRIA
Society for Industrial and Applied Mathematics
Institut National de Recherche en Informatique et en
Automatique

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DEADLINE DATES

Hotel Reservations
November 2, 1991

Advance Conference Registration
November 25, 1991

ORGANIZING COMMITTEE

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Laboratory

Elaine Oran
U.S. Naval Research Laboratory

FUNDING AGENCIES

SIAM is conducting this conference with the partial support of the Air Force Office of Scientific Research and the Department of Energy.

GET-TOGETHERS

Welcoming Reception
Sunday, December 1
7:00 PM - 9:00 PM
Tarpon Key Room
Cash bar and assorted mini hors d'oeuvres.

Meet-and-Greet Hour
Monday, December 2
5:30 PM - 6:30 PM
Stop in after the sessions are over to meet new colleagues or greet old friends to talk about the day or just make plans for the evening. There will be cold beer, assorted sodas, and chips and pretzels with dip. Weather permitting, we will meet down by the beach. If weather is threatening, we will meet in the Fountain Court.

Following are subject classifications for the sessions. The codes in parentheses designate session type and number. The session types are: invited (IP), minisymposium (MS), and contributed (CP).

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> > Physics (MS6, page 17)
> Numerics and Asymptotics: Some Basic Models in High Speed
> > Propulsion (MS9, page 21)

Complex Chemistry
> Japanese Numerical Combustion (MS3, page 11)
> Methods of Approximation for Calculating Structures of Real
> > Flames (IP2, page 8)
> Reduced Mechanisms for Combustion Calculations (MS2, page 9)

Detonations and Detonation Stability
> Comparison of Numerical Methods for Detonation Simulations
> > (MS10, page 23)
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> Numerical Simulation of Several Reacting Gas Dynamic
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> > Physics (MS6, page 17)

Drops and Sprays
> Droplets and Sprays (CP1, page 10)
> Droplet and Spray Analysis (MS8, page 20)

Fires
> Mathematical Modeling of Fires (MS4, page 11)

Flame-Vortex Interaction
> Simulations Specialized to Reveal Combustion Essentials
> > (MS1, page 9)

Ignition
> Ignition (CP2, page 10)

Industrial Applications
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> Successes and Failures in Numerical Simulation of
> > Gas-Turbine Combustion (IP6, page 20)
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Laminar Flames
> Laminar Diffusion Flames (CP9, page 15)
> Laminar Premixed Flames 1, 2, 3, 4, and 5 (CP 11, CP14,
> > CP16, CP18 and CP20, pages 18, 19, 22, 24, and 25), respectively
> Modeling Multidimensional Flames (IP3, page 14)
> Numerical Simulation of Laminar Reactive Flow (IP4, page 14)

Multiphase Combustion
> Multiphase Combustion 1, 2, and 3 (CP5, CP8, and CP19,
> > pages 13, 15, and 24), respectively

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New Numerical Methods
  Grid-Free Simulation of Reacting Shear Flow at High Reynolds
    Number (IP1, page 8)
  Modeling and Algorithms 1 and 2, (CP3 and CP6, pages 12 and
    13), respectively

Supersonic Combustion
  Computational and Theoretical Approaches to Supersonic
    Reacting Flows (MS5, page 14)
  Numerical Simulation of Laminar Reactive Flow (IP4, page 14)
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    (MS1, page 9)
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    Gas-Turbine Combustion (IP6, page 20)
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    CP21, pages 16, 18, 19, 22, and 25), respectively
  Turbulent Combustion (MS11, page 23)

1992 Conference Highlights

January 27-29, 1992
**Third ACM-SIAM
Symposium on
Discrete Algorithms**
Clarion Hotel, Orlando, FL
*Sponsored by ACM-SIGACT and
SIAM Activity Group*
on Discrete Mathematics
Organizer: Greg Frederickson,
Purdue University

May 11-13, 1992
**Fourth SIAM Conference
on Optimization**
Hyatt Regency Hotel, Chicago, IL
*Sponsored by SIAM Activity Group
on Optimization*
Co-organizers: Jorge Moré,
Argonne National Laboratory,
and Jorge Nocedal,
Northwestern University
Abstract Deadline: 10/11/91

June 8-11, 1992
**Sixth SIAM Conference
on Discrete Mathematics**
University of British Columbia,
Vancouver, Canada
*Sponsored by SIAM Activity Group
on Discrete Mathematics*
Organizer: Pavol Hell,
Simon Fraser University, Canada
Abstract Deadline: 11/15/91

July 19-24, 1992
**SIAM 40th Anniversary
Meeting** ☆ ☆ ☆
Century Plaza Hotel,
Los Angeles, CA
Organizer: James M. Hyman,
Los Alamos National Laboratory
Abstract Deadline: 1/6/92

September 17-19, 1992
**SIAM Conference on Control
and Its Applications**
Radisson Hotel Metrodome
Minneapolis, MN
*Sponsored by SIAM Activity Group
on Control and Systems Theory*
Organizer: Kevin A. Grasse,
University of Oklahoma, Norman
Abstract Deadline: 2/14/92

October 15-19, 1992
**SIAM Conference on
Applications of Dynamical
Systems**
Snowbird Ski and Summer Resort
Hotel, Salt Lake City, UT
*Sponsored by SIAM Activity Group
on Dynamical Systems*
Co-organizers: Peter W. Bates,
Brigham Young University,
and Christopher K.R.T. Jones,
Brown University
Abstract Deadline: 3/13/92

PROGRAM-AT-A-GLANCE

Monday, December 2

7:30   **Registration opens**
Fountain Courtyard

8:15   **Welcoming Remarks**
John Buckmaster
Long Key Ballroom

8:30   **IP1 Grid-free Simulation of Reacting Shear Flow at High Reynolds Number**
Ahmed F. Ghoniem
Long Key Ballroom

9:15   **IP2 Methods of Approximation for Calculating Structures of Real Flames**
Forman A. Williams
Long Key Ballroom

10:00   **Coffee**
Sabal Room

10:30   **Concurrent Sessions (Minisymposia and Contributed)**

MS1 Simulations Specialized to Reveal Combustion Essentials
Organizer: William T. Ashurst
Jasmine Room

MS2 Reduced Mechanisms for Combustion Calculations
Organizer: Norbert Peters
Long Key Ballroom

CP1 Droplets and Sprays
Palm Room

CP2 Ignition
Banyan Room

12:30   **Lunch**

2:00   **MS3 Japanese Numerical Combustion**
Organizer: Tadao Takeno
Long Key Ballroom

MS4 Mathematical Modeling of Fires
Organizer: Ronald G. Rehm
Jasmine Room

CP3 Modeling and Algorithms 1
Palm Room

CP4 Detonations 1
Banyan Room

4:00   **Coffee**
Sabal Room

4:30   **Concurrent Sessions (Contributed)**

CP5 Multiphase Combustion 1
Long Key Ballroom

CP6 Modeling and Algorithms 2
Jasmine Room

CP7 Detonations 2
Palm Room

CP = Contributed Presentation; IP = Invited Presentation; MS = Minisymposium

Tuesday, December 3

8:00   **Registration Opens**
Fountain Courtyard

8:30   **IP3 Modeling Multidimensional Flames**
Mitchell Smooke
Long Key Ballroom

9:15   **IP4 Numerical Simulation of Laminar Reactive Flow**
Bernard Larrouturou
Long Key Ballroom

10:00   **Coffee**
Sabal Room

10:30   **Concurrent Sessions (Minisymposia and Contributed)**

MS5 Computational and Theoretical Approaches to Supersonic Reacting Flows
Organizer: Elaine Oran
Long Key Ballroom

CP8 Multiphase Combustion 2
Banyan Room

CP9 Laminar Diffusion Flames
Jasmine Room

CP10 Turbulence 1
Palm Room

12:30   **Lunch**

2:00   **Concurrent Sessions (Minisymposia and Contributed)**

MS6 Numerics and Asymptotics: A Symbiotic Approach to Detonation Physics
Organizer: Ashwani Kapila
Banyan Room

MS7 Modelling and Simulation of Time-dependent Combustion Phenomena
Organizer: Bernd Rogg
Palm Room

CP11 Laminar Premixed Flames 1
Jasmine Room

CP12 Turbulence 2
Long Key Ballroom

4:00   **Coffee**
Sabal Room

4:30   **Concurrent Sessions (Contributed)**

CP13 Supersonic Combustion
Palm Room

CP14 Laminar Premixed Flames 2
Jasmine Room

CP15 Turbulence 3
Long.Key Ballroom

CP = Contributed Presentation; IP = Invited Presentation; MS = Minisymposium
Contributed presentations in a session are spaced twenty minutes apart, which allows fifteen minutes for each presentation and five minutes for discussion. Minisymposium talks are spaced thirty minutes apart, which allows for twenty-five minutes for each presentation and five minutes for discussion.

Wednesday, December 4

8:00   **Registration opens**
Fountain Courtyard

8:15   **Closing Remarks by Mitchell D. Smooke**
Long Key Ballroom

8:30   **IP5 Numerical Simulation of Several Reacting Gas Dynamic Phenomena**
Toshi Fujiwara
Long Key Ballroom

9:15   **IP6 Successes and Failures in Numerical Simulation of Gas-Turbine Combustion**
Sanjay M. Correa
Long Key Ballroom

10:00   **Coffee**
Sabal Room

10:30   **Concurrent Sessions (Minisymposia and Contributed)**
MS8 Droplet and Spray Analysis
Organizer: William A. Sirignano
Palm Room

        MS9 Numerics and Asymptotics: Some Basic Models in High Speed Propulsion
Organizer: Thomas L. Jackson
Banyan Room

        CP16 Laminar Premixed Flames 3
Jasmine Room

        CP17 Turbulence 4
Long Key Ballroom

12:30   **Lunch**

2:00   **Concurrent Sessions (Minisymposia and Contributed)**
MS10 Comparison of Numerical Methods for Detonation Simulations
Organizer: D. Scott Stewart
Palm Room

        MS11 Turbulent Combustion
Organizer: Stephen Pope
Long Key Ballroom

        CP18 Laminar Premixed Flames 4
Jasmine Room

4:00   **Coffee**
Sabal Room

4:30   **Concurrent Sessions (Minisymposia and Contributed)**
MS10 Comparison of Numerical Methods for Detonation Simulations *(Continuation from 2:00 PM)*
Palm Room

        CP19 Multiphase Combustion 3
Banyan Room

        CP20 Laminar Premixed Flames 5
Jasmine Room

        CP21 Turbulence 5
Long Key Ballroom

5:30   **Conference Adjourns**

CP = Contributed Presentation; IP = Invited Presentation; MS = Minisymposium

7:30/Fountain Courtyard
Registration Opens

8:15/Long Key Ballroom
Welcoming Remarks
John Buckmaster, University of Illinois, Urbana

8:30/Long Key Ballroom
IP1/Chair: Jay Boris, U.S. Naval Research Laboratory
Grid-free Simulation of Reacting Shear Flow at High Reynolds Number
In the numerical simulation of high-Reynolds number, reacting shear flows, the streamlines suffer severe distortion resulting from the growth of successive instability modes which cause initially parallel streamlines to become curved in the plane and normal to the plane of the flow. Moreover, mixing in these flows is dominated by convective entrainment. Hence the propagation of reaction fronts closely follows the streamlines. In this context, Lagrangian, grid-free methods offer desirable properties.

This presentation focuses on the construction and application of the transport element method, a natural extension of the vortex method in which species conservation equations are solved by transporting the corresponding scalar gradients.

Ahmed F. Ghoniem
Department of Mechanical Engineering
Massachusetts Institute of Technology

9:15/Long Key Ballroom
IP2/Chair: Jay Boris, U.S. Naval Research Laboratory
Methods of Approximation for Calculating Structures of Real Flames
Real flames are described by the equations of chemically reacting fluid flow with typically 20 to 2000 elementary reaction steps. Three-dimensional time-dependent numerical computation of flames with so many steps is beyond the capability of computers in the forseeable future. Therefore, simplifications in the chemical kinetics and in the fluid mechanics are needed if progress is to be made. Asymptotic methods afford avenues for identifying reduced chemical-kinetic mechanisms that involve fewer steps and for locating flow regions that maintain simplified balances. The speaker will discuss some of these simplifications for both premixed flames and diffusion flames.

Forman A. Williams
Department of Applied Mechanics and Engineering Sciences
University of California, San Diego

10:00-10:30/Sabal Room
Coffee

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MS1/Jasmine Room
Simulations Specialized to Reveal Combustion Essentials
Numerical simulations that treat one aspect of combustion in great detail, but treat other aspects more crudely, have been developed in order to highlight various aspects of combustion. Thus, full computer power is devoted to a single feature in each model and does that feature well, rather than poorly representing all features. The linear eddy model involves a one-dimensional representation of the thin diffusive layers found in turbulent mixing. Vortex rings are used to simulate the unsteady entrance flow in a pulse combustor and the impact of strain-rate quenching on premixed flame propagation is revealed in the rate of heat release. Direct simulations of constant density Navier-Stokes turbulence have been used to determine premixed flame geometry and the magnitude of differential diffusion.

In this minisymposium, the speakers will present different, detailed viewpoints of combustion. Detailed chemical kinetics has not been included but the results point out which chemical-flow configurations are of interest in turbulent combustion. From detailed or reduced chemical analysis, these specialized simulations could be extended.

Organizer: William T. Ashurst
Sandia National Laboratories, Livermore

10:30 **Linear-Eddy Modeling: Concept and Applications**
Alan R. Kerstein, Sandia National Laboratories, Livermore

11:00 **Pulse Combustion: The Importance of Flame Extinction by Fluid Dynamic Strain**
Pamela K. Barr, Sandia National Laboratories, Livermore

11:30 **Differential Diffusion Effects in Homogeneous Turbulence**
Jacqueline H. Chen, Sandia National Laboratories, Livermore

12:00 **Geometry of Premixed Flames in Three-Dimensional Turbulence**
William T. Ashurst, organizer

MS2/Long Key Ballroom
Reduced Mechanisms for Combustion Calculations
Reduced mechanisms for combustion applications allow a considerable reduction in computer time and storage. By introducing steady state assumptions for intermediate species the number of the differential equations are considerably reduced. This requires that the proposed mechanism is tested for one-dimensional flames under various conditions of pressure, temperature and equivalence ratios.

The speakers will discuss recent advances in the development of reduced mechanisms, specific formulations, and comparisons with alternative approaches.

Organizer: Norbert Peters, Institüt für Technische Mechanik, RWTH Aachen, Germany

10:30 **Reduced Mechanisms for Hydrogen and Hydrocarbon Flames**
Fabian Mauss, Institüt für Technische Mechanik, RWTH Aachen, Germany

11:00 **Flamelet Libraries for the Numerical Solution of Complex Turbulent Combustion Problems in Research and Industry**
Bernd Rogg, University of Cambridge, United Kingdom

11:30 **Prediction of Soot Formation in Laminar and Turbulent Diffusion Flames**
Peter Lindstedt, Imperial College, United Kingdom

12:00 **Simplification of Chemical Kinetics by Constructing Low-Dimensional Manifolds in Composition Space**
Ulrich Maas, Universität Stuttgart, Germany and Stephen B. Pope, Cornell University

CP1/Palm Room
Droplets and Sprays
Chair: H.A. Dwyer, University of California, Davis

10:30 **Counterflow Diffusion Spray Flames using Complex Chemistry**
N. Darabiha, F. Lacas and J.C. Rolon, CNRS, École Central Paris, France

10:50 **Fuel Droplet Vaporization in an Acoustic Field**
A. Duvvur, C.H. Chiang and *W.A. Sirignano*, University of California, Irvine

11:10 **Numerical Modeling of Liquid Propellant Combustion Instability**
Y.M. Kim, Z.J. Chen, and C.P. Chen, University of Alabama, Huntsville

11:30 **Numerical Model for Evaporating and Combusting Fuel Sprays**
Y.M. Kim, H.M. Shang, and C.P. Chen, University of Alabama, Huntsville

11:50 **Distribution of Droplet Mass Fraction in the Entrance Region of a Dispersed Flow in Horizontal Pipes**
Xin-sheng Yang and Hubert Mainardi, E.S.E.M. Université d'Orleans, France

12:10 **A Critical Evaluation of the Constant Vaporization Damkohler Number Assumption in the Mathematical Analysis of Laminar Spray Diffusion Flames**
J.B. Greenberg and N. Sarig, Technion-Israel Institute of Technology, Israel

CP2/Banyan Room
Ignition
Chair: F.L. Dryer, Princeton University

10:30 **Comparison of Ignition Phenomena Modelled with Detailed and Simplified Kinetics**
T.M. Sloane, General Motors Research Laboratories and *P.D. Ronney*, Princeton University

10:50 **Detailed Numerical Simulation of One-Dimensional Ignition Processes Induced by Hot Spots**
G. Goyal, U. Maas, and *J. Warnatz*, Universität Stuttgart, Germany

11:10 **Ignition of Dilute Fuel Sprays Employing Detailed Chemistry**
Eva Gutheil and Jurgen Warnatz, Universität Stuttgart, Germany

11:30 **Computational Study of Laser-Induced Thermal Ignition in Premixed Ethylene-Oxidizer Mixtures**
Michael A. Tanoff, Yale University and Chalmers University of Technology, Sweden; Mitchell D. Smooke, Yale University; Jeffrey A. Sell and Richard E. Teets, General Motors Research Laboratories

11:50 **Multidimensional Calculation of Spark Flame Initiation and Propagation with a Generic Hydrocarbon Kinetic Scheme**
Reinhard Tatschl, Bizhan Ahmadi-Befrui and Wilhelm Brandstatter, AVL-List GmbH, Austria

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12:30
Lunch

2:00-4:00
Concurrent Sessions (Minisymposia and Contributed)

MS3/Long Key Ballroom
Japanese Numerical Combustion
The main stream of combustion study in Japan has traditionally been the phenomenological approach based on experimental findings. However, recent remarkable progress in computer software, as well as in the hard-. ware, is going to change this situation. The numerical approach is becoming more and more popular. There are two groups working in this area. The first group is mainly concerned with the chemical kinetics in the simple flow systems, while the second one intends to describe the combustion flow field by adopting simplified kinetics. In this minisymposium, two speakers from the respective groups will provide an overview of their recent studies.

Organizer: Tadao Takeno
Nagoya University, Japan

2:00 **Flame Ignition of Premixed Methane Air Mixtures by a High Temperature Body**
Taeko Sano, Tokai University, Japan

2:30 **Methane-air Premixed Flame Structure by Two-dimensional Simulation**
Seishiro Fukutani, Kyoto University, Japan

3:00 **Simulation of 3-D Premixed Flame in Engine**
Ken Naitoh, NISSAN Motor Co., Ltd., Japan and Kunio Kuwahara, Institute of Space and Astronautical Science, Japan

3:30 **Characteristics of Turbulent Fluctuations in Jet Diffusion Flames**
Hiroshi Yamashita, Genichiro Kushida and *Tadao Takeno*, organizer, Nagoya University, Japan

MS4/Jasmine Room
Mathematical Modeling of Fires
Combustion is an essential component in unwanted fires. However, the mathematical modeling of fires requires the study of more phenomena than combustion alone, phenomena such as buoyant convection, heat transfer to surfaces, smoke dynamics, and radiative transfer must be modeled. The purpose of this minisymposium is to describe some of the problems encountered in the modeling of fires and some of the approaches to solving them.
Unwanted fires have long been a substantial and unpredictable drain on human and economic resources. Over the past few decades, mathematical and computational modeling has become an indispensible tool for understanding unwanted fires. Room fires and fires in buildings have been the focus of most modeling. However, large oil spills from tankers, reconsideration of combustion as a means for cleanup, and the massive oil-well fires in Kuwait have brought increased attention to modeling of open fires.

Organizer: Ronald G. Rehm
National Institute of Standards and Technology

2:00 **Modeling of Fires**
Ronald G. Rehm, organizer, Hai C. Tang, Howard R. Baum, and James S. Sims, National Institute of Standards and Technology

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2:30   **Fundamentals of Enclosure Fire "Zone" Models**
James G. Quintiere, University of Maryland, College Park

3:00   **Applications of Field Modelling of Fires**
I.P. Jones and N.S. Wilkes, Harwell Laboratory, United Kingdom

3:30   **The Fluid Dynamics of Large Fires**
Howard R. Baum, National Institute of Standards and Technology

CP3/Palm Room
Modeling and Algorithms 1
Chair: S.H. Lam, Princeton University

2:00   **The Dynamics of Numerics of Nonlinear Source Terms in Reaction-Convection Equations**
Andre Lafon, ONERA-CERT, France and H.C. Yee, NASA Ames Research Center

2:20   **Acceleration of a 2-D Combustion Code Using MOSI to Solve the Pressure and Pressure Correction Fields for a SIMPLER Based Algorithm**
Stephen H. Barthelson, Brigham Young University

2:40   **Vorticity-Velocity Formulation for Three-Dimensional Steady Compressible Flows**
A. Ern, École Polytechnique, France and Yale University and M.D. Smooke, Yale University

3:00   **Parallel Computational Combustion**
William D. Gropp, Argonne National Laboratory and *David E. Keyes*, Yale University

3:20   **Convergent Iterative Methods for Multicomponent Diffusion**
V. Giovangigli, École Polytechnique, France

CP4/Banyan Room
Detonations 1
Chair: Joseph Shepherd, Rensselaer Polytechnic Institute

2:00   **Numerical Simulation of Inviscid Detonation Waves with Finite Rate Chemistry**
Vinh Ton, Ann R. Karagozian, Bjorn E. Engquist and Stanley J. Osher, University of California, Los Angeles

2:20   **Higher Order Numerical Simulations of Multi-dimensional Detonation Waves**
Wei Cai and You-lan Zhu, University of North Carolina, Charlotte

2:40   **Asymptotic and Numerical Predictions of Oblique Detonations with Simple Finite-Rate Chemistry**
Joseph M. Powers and Matthew J. Grismer, University of Notre Dame and Shaye Yungster, ICMP-NASA Lewis Research Center

3:00   **Detonation in Sprays**
Lionel Sainsaulieu, CERMICS, ENPC, France

3:20   **The Speed of Detonation Waves**
Jon K. Tegner, Royal Institute of Technology, Sweden

4:00-4:30/Sabal Room
Coffee

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Concurrent Sessions (Contributed)

CP5/Long Key Ballroom
Multiphase Combustion 1
Chair: Michael Delichatsios, Factory Mutual Research Corporation

4:30　**A Computational Model of the MOCVD GaAs**
　　　R.M. Zurn and M.D. Smooke, Yale University

4:50　**The Fluctuation Frequency of Pool Fires: A Simple**
　　　Predictive Approach
　　　Ishwar K. Puri, University of Illinois, Chicago and Anthony
　　　Hamins, National Institute of Standards and Technology

5:10　**Heat and Mass Transport from Heated Material in a Low**
　　　Reynolds Number Microgravity Environment
　　　Hiroshi Yamashita, Howard R. Baum and Takashi Kashiwagi,
　　　National Institute of Standards and Technology and Genichiro
　　　Kushida, Nagoya University, Japan

CP6/Jasmine Room
Modeling and Algorithms 2
Chair: Ann Karagozian, University of California, Los Angeles

4:30　**Identification of Intermediates and Fast Reactions in**
　　　Complex Kinetics Mechanisms Using CSP
　　　D.A. Goussis and *S.H. Lam*, Princeton University

4:50　**A Front-Tracking Scheme with Subcell Resolution**
　　　Capability
　　　Charlie H. Cooke and Tze-Jang Chen, Old Dominion
　　　University

5:10　**An Advanced Computing Environment for Numerical**
　　　Combustion Applications
　　　M. Bernaschi, M. Briscolini, F. Lozupone, M. Maggiore, F.
　　　Papetti, and P. Santangelo, IBM ECSEC, Italy; G. Chlatti, and
　　　S. Golini, Università di Roma, La Sapienza, Italy; and *S. Succi*,
　　　IBM ECSEC, Italy and Università di Roma, La Sapienza, Italy

CP7/Palm Room
Detonations 2
Chair: Martin Sichel, University of Michigan, Ann Arbor

4:30　**A Geometric Singular Perturbation Analysis of Detonation**
　　　and Deflagration Waves
　　　I. Gasser, C. Schmeiser, and *Peter Szmolyan*, Technical
　　　University-Wien, Austria

4:50　**Detonation Waves and the Front Tracking Method**
　　　Bruce G. Bukiet, New Jersey Institute of Technology and
　　　Ralph Menikoff, Los Alamos National Laboratory

5:10　**Dynamic Structure of Detonation Front**
　　　A.A. Borissov and O.V. Sharypov, USSR Academy of
　　　Sciences, USSR

8:00/Fountain Courtyard
Registration Opens

8:30/Long Key Ballroom
IP3/Chair: Charles Westbrook, Lawrence Livermore National Laboratory
Modeling Multidimensional Flames
The ability to predict the coupled effects of complex transport phenomena with detailed chemical kinetics is critical in the modeling of turbulent reacting flows, in improving engine efficiency, and in understanding the processes by which pollutants are formed. While the majority of multistep kinetic flame studies in the literature have been one-dimensional in nature, recent advances in the development of computational algorithms, reaction kinetics and mainframe supercomputers can enable the combustion scientist to investigate chemically reacting systems that were computationally infeasible only a few years ago. In this talk, we focus our attention on one such system—the axisymmetric laminar flame. We discuss issues related to the modeling of the fluid dynamic and thermochemistry solution fields on both serial and parallel computers and we provide an assessment as to the applicability of partial equilibrium/full equilibrium and reduced chemistry submodels.

Mitchell D. Smooke
Department of Mechanical Engineering
Yale University

9:15/Long Key Ballroom
IP4/Chair: Charles Westbrook, Lawrence Livermore National Laboratory
Numerical Simulation of Laminar Reactive Flow
In many laminar or turbulent reactive flows, the effects related to the compressibility of the gases involved in the combustion process are important. The development of adequate numerical methods, which remain robust, efficient and stable for compressible reactive flows at different regimes is therefore needed.

The emphasis in this presentation will be put on the description of the available numerical methods for these flows and their applications in a variety of situations including subsonic premixed or diffusion flames and supersonic reactive jet interaction.

Bernard Larrouturou
CERMICS, INRIA
Sophia-Antipolis, France

10:00-10:30/Sabal Room
Coffee

10:30-12:30
Concurrent Sessions (Minisymposia and Contributed)

MS5/Long Key Ballroom
Computational and Theoretical Approaches to Supersonic Reacting Flows
When the energy release or the fluid flow is very fast, shock waves can develop, fluid-dynamic effects can dominate diffusive phenomena, compressibility effects in turbulence become important, and detonation waves may appear. The speakers in this minisymposium will discuss results of fundamental numerical and theoretical approaches to several different

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kinds of supersonic reactive flows. The multidimensional computations of detonations show basic structures of propagating detonation waves in gas-phase, condensed-phase, and multiphase media that are important features to consider for explosive safety and design. The computations of structure and mixing in reacting and nonreacting supersonic shear flows may describe astrophysical phenomena and are important in designing efficient supersonic aircraft.

Organizer: Elaine Oran
U.S. Naval Research Laboratory

10:30 **Computations of Multidimensional Supersonic Reacting Flows**
Elaine Oran, organizer

11:00 **Numerical Modeling of Heterogeneous Detonations**
Martin Sichel, University of Michigan, Ann Arbor

11:30 **Large-Eddy Simulation of Supersonic Shear Layers**
Bakhtier Farouk, Drexel University

12:00 **Mixing Enhancement of Reacting Parallel Fuel Jets in a Supersonic Flow Field**
J. Philip Drummond, NASA Langley Research Center

CP8/Banyan Room
Multiphase Combustion 2
Chair: Howard R. Baum, National Institute of Standards and Technology

10:30 **Mathematical Model for Smoldering Combustion**
John C. Edwards, U.S. Department of the Interior

10:50 **Effect of Radiation on the Flame Stabilization Over a Solid Fuel Plate**
Seung Wook Baek and Jeong Soo Kim, Korea Advanced Institute of Science and Technology, Korea; and Carolyn R. Kaplan, Naval Research Laboratory

11:10 **A Hydrodynamic Stability Analysis of Wind-Aided Flame Spread Across a Ceiling**
Sanjay Agrawal and Indrek S. Wichman, Michigan State University

11:30 **Asymptotic, Approximate and Numerical Solutions for the Transient Heat-up, Ignition and Pyrolysis of Burning Materials Including Reradiation Losses**
Michael A. Delichatsios and Yonggang Chen, Factory Mutual Research Corporation

11:50 **Particle Mixing for Combustion**
Moti L. Mittal, Ohio Supercomputer Center and Urmila Ghia, University of Cincinnati

12:10 **Numerical Count of Temperature Structure of Wave SHS in System with Complex Form**
Aleksei Gennadievich Terekhov and Victor Deamidovich Gladun, Institut Metallurgii i Obogashenia AN Kaz SSR, USSR

CP9/Jasmine Room
Laminar Diffusion Flames
Chair: Jürgen Warnatz, Universität Stuttgart, Germany

10:30 **Velocity Effects on the Dynamic Behavior of the H2-N2 Diffusion Flame**
K. Viswanath Reddy and W.M. Roquemore, Wright Laboratories/POSF

10:50 **A Numerical/Experimental Investigation of the Dynamic Structure of a Buoyant Jet Diffusion Flame**

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R.W. Davis and E.F. Moore, National Institute of Standards and Technology; L-D. Chen, University of Iowa; W.M. Roquemore, WRDC/Aero Propulsion Laboratory; and L.P. Goss, Systems Research Laboratories, Inc.

11:10 **A Numerical Study of an Ethylene Diffusion Flame**
Carolyn R. Kaplan, Naval Research Laboratory; Seung W. Baek, Korea Advanced Institute of Science and Technology, Korea; Janet L. Ellzey, University of Texas, Austin; and Elaine S. Oran, Naval Research Laboratory

11:30 **Primitive Variable Solution of a Confined Laminar Diffusion Flame Using a Detailed Reaction Mechanism**
Yuenong Xu and Mitchell D. Smooke, Yale University

11:50 **A Numerical Study of the Leading Edge of Laminar Diffusion Flames**
Kuldeep Prasad, Robert K. Sigman, and Edward W. Price, Georgia Institute of Technology

12:10 **Numerical Simulation of the Ignition of a Diffusion Flame Rolled-Up in a Vortex**
Dominique Thevenin and Sebastien Candel, École Centrale Paris, France

CP10/Palm Room
Turbulence 1
Chair: Julian Tishkoff, Air Force Office of Scientific Research

10:30 **Turbulent Reactive Gaseous Jet Flow in an Axisymmetric Enclosure**
Farrokh Issacci, Ann R. Karagozian, and Owen I. Smith, University of California, Los Angeles

10:50 **Numerical Simulation of a Premixed V-Shaped Flame**
B. Roche, *G. Brun* and D. Escudie, École Central de Lyon, France

11:10 **A Linear Eddy Flamelet Subgrid Model for Large-Eddy Simulations of Turbulent Premixed Combustion**
Suresh Menon, QUEST Integrated, Inc.; Patrick A. McMurtry, University of Utah; and Alan R. Kerstein, Sandia National Laboratoires

11:30 **A Linear Eddy Sub-Grid Model for Turbulent Mixing and Reaction**
Patrick A. McMurtry, University of Utah; Suresh Menon, Quest Integrated, Inc.; and Alan R. Kerstein, Sandia National Laboratories

11:50 **Investigation of the Mixture Fraction PDF**
William Mell, *George Kosaly*, and James J. Riley, University of Washington

12:10 **Influence of Turbulence on a Flame Kernel**
Elna M.B. Holmberg, Royal Institute of Technology, Sweden

12:30

Lunch

2:00-4:00
Concurrent Sessions (Minisymposia and Contributed)

MS6/Banyan Room
Numerics and Asymptotics: A Symbiotic Approach to Detonation Physics

The theme of the minisymposium is the notion that numerics is at its most reliable when aided, inspired, or guided by analysis. The speakers will describe recent and ongoing work that subscribes to this premise and explores, via a complementary analytical/numerical approach, the topics of detonation structure, evolution and propagation. The presentation by Dold will concentrate on numerical methods designed to capture, accurately and reliably, transient features that always seem to participate in evolution towards detonation. Shepherd will present numerical computations of detonation structure based on the ZND model, including detailed kinetics and realistic thermochemical properties, and compare the results with those of simplified models. Bdzil will discuss the numerical implementation of the Bdzil-Stewart Detonation-Shock-Dynamics theory for realistic geometries, and describe how the results compare with actual observations.

Organizer: Ashwani Kapila
Rensselaer Polytechnic Institute

2:00 **Numerical Verification of Asymptotic Predictions Concerning Detonation Initiation**
J.W. Dold, University of Bristol, United Kingdom and Ashwani Kapila, organizer

2:30 **Numerical Analysis of Detonation Structure**
Joseph E. Shepherd, Rensselaer Polytechnic Institute

3:00 **Two-Dimensional Detonation Front Tracking: A Comparison of Asymptotic and Numerical Modeling and Experimental Observation**
J.B. Bdzil, Los Alamos National Laboratory

3:30 **Additional speaker and title to be announced.**

MS7/Palm Room
Modelling and Simulation of Time-Dependent Combustion Phenomena

Real-life combustion is an instationary, three-dimensional, turbulent phenomenon. Whilst an appreciable amount of theoretical, numerical and experimental research has been devoted to the complex subject of statistically stationary turbulent flows, relatively little attention has been given to the modelling and simulation of time-dependent, multi-dimensional, laminar or turbulent, chemically reacting flows. It is the purpose of this minisymposium to report on the progress of and, thereby, to stimulate further interest in the modelling and simulation of both laminar and turbulent multidimensional combustion phenomena.

The numerical solution of combustion problems usually requires the solution of large non-linear systems of equations. The general approach to the solution of the non-linear systems is to linearize them, for instance, by Newton's methods. Sophisticated linear-algebra software is required to solve the linear systems of equations.

Organizer: Bernd Rogg
University of Cambridge, United Kingdom

2:00 Modelling and Simulation of Time-Dependent Combustion Phenomena
Bernd Rogg, organizer

2:30 Domain-Adaptive Techniques for Two-Dimensional, Time-Dependent Chemically Reactive Flows
J.I. Ramos, Carnegie-Mellon University

3:00 Detailed, Transient, Two-Dimensional Simulations of Laminar Flame Structures in Lean Hydrogen-Air Mixtures
Gopal Patnaik, U.S. Naval Research Laboratory

3:30 Unsteady Dynamics of Boundaries Between Burning and Non-Burning
J.W. Dold, University of Bristol, United Kingdom

CP11/Jasmine Room

Laminar Premixed Flames 1
Chair: Arje Nachman, Air Force Office of Scientific Research

2:00 Modeling of Microgravity Combustion Phenomena
John Buckmaster, University of Illinois, Urbana

2:20 Premixed Flame Stability in a Stagnation Flow to General Disturbances
Moshe Matalon, Northwestern University and T.L. Jackson, Old Dominion University

2:40 The Response of Premixed Flames to Temporally Periodic Straining Flows
David W. Mikolaitis, University of Florida

3:00 Analytical Solution of a Near-Equidiffusional Flame Problem
Glenn Ledder, University of Nebraska, Lincoln

3:20 Pressure Wave Steepening in Premixed Flame-Pressure Pulse Interactions
A.C. McIntosh, G. Batley, and J. Brindley, Leeds University, United Kingdom

CP12/Long Key Ballroom

Turbulence 2
Chair: Sebastien Cantel, École Central Paris, France

2:00 A Combustion Model for Incompressible Flows
Maria E. Calzada, Loyola University

2:20 A Random Choice Method with a Dictionary Approach for Turbulent Combustion
Yu Song, Tulane University

2:40 Turbulent Flames Close to Extinction: A Discussion in Context of the Flamelet Theory
Ishwar K. Puri, University of Illinois, Chicago

3:00 Turbulent Flames Close to Extinction. Part II: Survival Probability During Random Walks
Ishwar K. Puri, University of Illinois, Chicago

3:20 Numerical Modelling of Three-Dimensional Flows within the Cylinder of a Direct Injection Diesel Engine
Alberto A. Boretti and M.G. Lisbona, FIAT Research Center, Italy

3:40 Numerical Modelling of Three-Dimensional Flows within the Cylinder of a 4 Valve Spark Ignition Engine
Alberto A. Boretti and M.G. Lisbona, FIAT Research Center, Italy

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4:30-5:30
Concurrent Sessions (Contributed)

CP13/Palm Room
Supersonic Combustion
Chair: M.Y. Hussaini, ICASE-NASA Langley Research Center

4:30 The Thermodynamical Behavior in the Optimization of
Supersonic Combustor for Some Flight Regimes
Carlos Frederico Estrada Alves, Polytechnic Institute of Rio de
Janeiro, Brazil; Leon R. Sinay, Institute for Space Research,
Brazil; and Demetrio Bastos-Netto, Institute for Space
Research and University of California, San Diego

4:50 Computation of Oscillating Shock-Induced Combustion
Observed in Ballistic-Range Experiments
Gregory J. Wilson and Myles A. Sussman, Stanford University

CP14/Jasmine Room
Laminar Premixed Flames 2
Chair: V. Giovangigli, École Polytechnique, France

4:30 A Numerical Simulation of the Rayleigh-Taylor Instability
in Premixed Flame Propagation
A.C. McIntosh, F. Liu, and J. Brindley, Leeds University,
United Kingdom

4:50 The Mass Burning Rate Response of a Premixed Flame to
Sharp Pressure Changes
A.C. McIntosh, Leeds University, United Kingdom

5:10 Flame Extinction in Models of Laminar Flames
Joel D. Avrin, University of North Carolina, Charlotte and
James F. Epperson, University of Alabama, Huntsville

CP15/Long Key Ballroom
Turbulence 3
Chair: Thierry Poinsot, École Central de Paris, France

4:30 Simulation of Combustion and Nox Formation in Gas-
andOil-Fired Furnaces
G. De Michele and S. Malloggi, ENEL-Centro Ricerche Termiche
e Nucleari, Italy; S. Merlini, MATEC, Milano, Italy; and S. Pasini,
ENEL-Centro Ricerche Termiche e Nucleari, Italy

4:50 Modeling of Combustion Processes in an Industrial Furnace
Fired by Oxy-Fuel Burners
Bakhtier Farouk and Christopher J. McKenna, Drexel University

5:10 Modeling of Sulphur Plant Reaction Furnace
Mark K.Y. Lai, National Research Council Canada

8:00/Fountain Courtyard
Registration Opens

8:15/Long Key Ballroom
Closing Remarks

8:30/Long Key Ballroom
IP5/Chair: Elaine Oran, U.S. Naval Research Laboratory
Numerical Simulation of Several Reacting Gasdynamic Phenomena
The speaker will focus on stiff problems of chemically reacting flows with exothermicity. He will discuss computational aspects like grid generation, and accuracy of numerical techniques, and physical interpretations of numerous interesting phenomena like multiple Mach reflections and galloping in self-sustaining detonations. The problems he will address include three-dimensional detonation propagating in a circular tube, laser-supported detonation in hydrogen/air, oblique detonation in oxyhydrogen mixtures, reacting shear layer and its development into turbulent flame, and three-dimensional structure of shear layer.

Toshi Fujiwara
Department of Aeronautical Engineering
Nagoya University, Japan

9:15/Long Key Ballroom
IP6/Chair: Elaine Oran, U.S. Naval Research Laboratory
Successes and Failures in Numerical Simulation of Gas-Turbine Combustion
To be useful in practice, combustion models must predict parameters such as efficiency, NOx, CO and SOx emissions, and life. Physico-chemical modeling and numerical techniques are not yet advanced enough, however, to address all relevant issues.

The speaker will present examples of success and failure in the numerical simulation of gas-turbine combustion. For example, the k-e/assumed shape pdf/fast chemistry model is adequate for gross velocity and temperature fields and for thermal NOx in non-premixed 3D combustors. Stirred flow reactors can predict NOx in lean intensely turbulent premixed flames, but CO and hydrocarbons involve intimate interaction between kinetics and chemistry and are not predicted well. Unsteady models are needed to account for dynamics. Even though a single comprehensive code does not exist models are making an impact.

Sanjay M. Correa
General Electric Research Center

10:00-10:30/Sabal Room
Coffee

10:30-12:30
Concurrent Sessions (Minisymposia and Contributed)

MS8/Palm Room
Droplet and Spray Analysis
Spray combustion science is relevant to many power and propulsion applications where liquid fuel is directly injected into a combustion cham-

ber. Computational fluid dynamics is becoming more important in the study of this two-phase flow phenomenon. The minisymposium will cover vital computational issues concerning interacting droplets, transient heating and vaporization, radiative heating of droplets, chemical reaction in the gas film surrounding droplets, and internal liquid circulation. Numerical methods and results concerning detailed flow, thermal, and compositional fields within and around vaporizing droplets will be discussed.

Organizer: William A. Sirignano
University of California, Irvine

10:30 **A Study of Droplet Spray Combustion by Numerical Simulation**
R. Borghi and S. Loison, University of Rouen, France

11:00 **Mathematical Modeling of Droplet Combustion**
S.Y. Cho and F.L. Dryer, Princeton University

11:30 **Droplet Ignition Calculations with Detailed Chemistry**
H.A. Dwyer, University of California, Davis

12:00 **Numerical Computations of Droplet Vaporization Including Radiaton Absorption Effects**
R.H. Rangel and P.L. Lage, University of California, Irvine

MS9/Banyan Room
Numerics and Asymptotics: Some Basic Models in High Speed Propulsion

The focus of this minisymposium is on some basic models in high speed propulsion. Each model presented employs a combination of asymptotic and numerical methods, and the need for this dual approach is emphasized. These models, currently under investigation at NASA Langley Research Center, are designed to aid in the understanding of basic physical phenomena for either the SCRAMJET Engine or the Oblique Detonation Wave Engine (ODWE). Since compressibility cannot be neglected, this area of research continues to provide a challenge for mathematical modelers trying to understand the interaction between hydrodynamic and combustion processes.

The National Aerospace Plane (NASP) project has brought out the need for understanding combustion phenomena in supersonic and hypersonic flows where compressibility effects peculiar to such flows cannot be neglected. There has been practically no theory of ignition, flame structure, stability and propagation in these flows owing to the absence of physical models that are simple enough for analytical approach while simulating numerically observed phenomena. This minisymposium is designed to encourage the development of such models.

Organizer: Thomas L. Jackson
Old Dominion University

10:30 **Ignition and Structure of Diffusion Flame-Vortex Interactions**
Michele G. Macaraeg, NASA Langley Research Center; Thomas L. Jackson, organizer and M.Y. Hussaini, ICASE, NASA Langley Research Center

11:00 **Disturbance Patterns Associated with an Oblique Detonation Wave**
D. Glenn Lasseigne, Old Dominion University and M.Y. Hussaini, ICASE, NASALangley Research Center

11:30 **Absolute/Convective Instabilities in a Compressible Mixing Layer with Finite Rate Chemistry**
Chester E. Grosch, F.Q. Hu, and Thomas L. Jackson, organizer

12:00 **Vorticity/Detonation Wave Interactions**
Thomas L. Jackson, organizer and D. Glenn Lasseigne, Old Dominion University and M.Y. Hussaini, ICASE, NASA Langley Research Center

12:30 **Numerical Simulation of Shock-Induced Combustion/ Detonation in a Premixed H2-Air Mixture**
Dal J. Singh, Analytical Services and Materials Inc.; Mark H. Carpenter and Ajay Kumar, NASA Langley Research Center

CP16/Jasmine Room
Laminar Premixed Flames 3
Chair: M. Birkan, Air Force Office of Scientific Research

10:30 **Premixed-Flame Propagation in Spatially Periodic Shear Flow**
Ralph Curtis Aldredge, III, California Institute of Technology and Forman A. Williams, University of California, San Diego

10:50 **A Computational Study of Methane/Air Combustion Above a Heated Catalytic and Non-Catalytic Flat Plate**
Penelope Markatou, Pennsylvania State University; Mitchell D. Smooke and Lisa D. Pfefferle, Yale University

11:10 **Numerical Modeling of Flame Extinction in Shear Flow**
Gregory Kozlovsky and G.I. Sivashinsky, City College of The City University of New York

11:30 **Numerical Simulation of Axisymmetric Premixed Bunsen Flames**
V. Giovangigli, École Polytechnique, France and Mitchell D. Smooke, Yale University

11:50 **An Unstructured Navier-Stokes Solver for Laminar Combustion**
Alan C. Mueller, QUEST Integrated, Inc.

12:10 **Vortex Driven Modifications of the Structure of Premixed Flames with Non-Unity Lewis Number**
Arnaud Trouve, Stanford University and Thierry Poinsot, École Centrale de Paris, France

CP17/Long Key Ballroom
Turbulence 4
Chair: Alan R. Kerstein, Sandia National Laboratories, Livermore

10:30 **Fractal Numerics in Turbulent Combustion**
Mazda A. Marvasti and *Warren C. Strahle*, Georgia Institute of Technology

10:50 **Incinerator Modeling Emphasizing Detailed Chemistry**
Robert B. Barat, New Jersey Institute of Technology

11:10 **Flame Surface Statistics by Direct Numerical Simulation**
Robert Stewart Cant, UMIST, United Kingdom

11:30 **Using Numerical Simulation to Study Flamelets in Premixed Turbulent Combustion**
Thierry Poinsot, École Centrale Paris, France; Arnaud Trouve, Center for Turbulence Research; Daniel Haworth, General Motors Research Laboratory; and Christopher Rutland, University of Wisconsin, Madison

11:50 **Using Numerical Simulation to Study the Ignition of Flames in Premixed Turbulent Flowfields**
Markus Baum and Thierry Poinsot, École Centrale Paris, France

12:30
Lunch

2:00-4:00
Concurrent Sessions (Minisymposia and Contributed)

MS10/Palm Room (2:00-5:30 PM)
Comparison of Numerical Methods for Detonation Simulations

The minisymposium will focus on quantitative comparisons among numerical methods for the reacting Euler equations in one and two dimensions. These methods include Godunov-based methods, front tracking, adaptive Lagrangian, and piecewise parabolic interpolation. The minisymposium participants have agreed to make calculations on a common set of problems simulating detonation, so that detailed comparisons can be made in a standard format. A goal of this minisymposium is to make progress towards establishing a standardized test suite for Euler codes with chemical reaction, similar to collections of analytical and numerical test problems used for verification in more mature computational disciplines.

Since recent progress has been made in comparisons of numerical simulations to linear stability results for detonation, there is interest in trying to understand the broader implications of stability results for predicting non-linear detonation evolution.

Organizer: D. Scott Stewart
University of Illinois, Urbana

2:00   **Simulation of Detonation with CAVEAT and CMHOG**
        D. Scott Stewart, organizer and James Stone, University of
        Illinois, Urbana

2:30   **A New High Resolution Numerical Method for Detonation
        Calculations**
        Anne Bourlioux and Andrew Majda, Princeton University

3:00   **Nonlinear Development of Detonation Instabilities**
        Victor Roytburd, Rensselaer Polytechnic Institute and Andrew
        Majda, Princeton University

3:30   **One and Two Dimensional Detonation Simulations at
        INRIA**
        Didier Chargy and Bernard Larrouturou, CERMICS, INRIA,
        Sophia-Antipolis, France

4:00   *Session will break for coffee*

4:30   **Simulations of Unsteady Detonation Waves**
        Tasso Lappas, Anthony Leonard and Paul E. Dimotakis,
        California Institute of Technology

5:00   **Test Suite Standardization for the Reactive Euler Equations**
        Michael Norman, University of Illinois, Urbana

MS11/Long Key Ballroom
Turbulent Combustion

Because of its importance in engineering applications, turbulent combustion continues to be an important research topic. In this minisymposium, recent work using two different computer-intensive techniques is described. In the first technique, direct numerical simulation (DNS), conservation equations are solved for the three-dimensional transient fields describing simple turbulent reactive flows. There are no modelling as-

sumptions, there is no difficulty in extracting information from the solution, but computation capacity places severe restrictions on the parameter range that can be studied. In the second technique, PDF methods, a modelled evolution equation for the joint pdf of flow variables is solved by Monte Carlo.

Organizer: Stephen B. Pope
Cornell University

2:00   **Numerical Issues in PDF Methods**
Stephen B. Pope, organizer

2:30   **PDF Modeling of Turbulent Nonpremixed Jet Flames**
J.-Y. Chen, Sandia National Laboratories, Livermore

3:00   **DNS and Multidimensional Modeling: Complementary Tools for Investigating Turbulent Combustion in IC Engines**
Daniel C. Haworth, General Motors Research Laboratories

3:30   **Direct Numerical Simulation of Turbulent Premixed Flames**
Thierry Poinsot, École Central de Paris, France

CP18/Jasmine Room
Laminar Premixed Flames 4
Chair: David W. Mikolaitis, University of Florida

2:00   **Evaluation of Chemical Kinetic Models for Hydrogen Air Combustion**
K.M. Isaac, University of Missouri, Rolla

2:20   **Kinetic Simulations of the Formation of Chlorinated Organics in a Medical Waste Incinerator**
Craig Saltiel, John Wagner, Mitchell Goodman, and *Alex Green*, University of Florida

2:40   **A Hybrid Asymptotic-Numerical Method for the Flame Propagation Problem, I: One-step, Plane Flame**
Raymond C.Y. Chin and Richard Y. Tam, Indiana University-Purdue University, Indianapolis

3:00   **A Hybrid Asymptotic-Numerical Method for the Flame Propagation Problem II: Multi-step, Plane Flame**
Raymond C.Y. Chin and *Richard Y. Tam*, Indiana University-Purdue University, Indianapolis

4:00-4:30/Sabal Room
Coffee

4:30-5:30
Concurrent Sessions (Contributed)

CP19/Banyan Room
Multiphase Combustion 3
Chair: Ishwar K. Puri, University of Illinois, Chicago

4:30   **Unsteady Diffusion Mass Transfer in Circulating Fluidized Beds**
P. Zamankhan, Valtion Teknillinen Tutkimuskeskus, Finland

4:50   **The Fractal Nature in Condensed Phase of the Temperature and Concentration Profiles in Reaction Front**
Aleksei Gennadievich Terekhov and Victor Deamidovich Gladun, Institut Metallurgii i Obogashenia AN Kaz SSR, USSR

5:10   **Numerical Modeling Wave of Combustion in Solid**
Aleksei Gennadievich Terekhov and Victor Deamidovich Gladun, Institut Metallurgii i Obogashenia AN Kaz SSR, USSR

CP20/Jasmine Room
Laminar Premixed Flames 5
Chair: Peter Lindstedt, Imperial College, United Kingdom

4:30 **Application of Continuation Methods to Plane Premixed Luminar Flames**
V. Giovangigli, Ecole Polytechnique, France and Mitchell D. Smooke, Yale University

4:50 **Numerical Simulation of Laminar Flames**
S. Arrigotti, S. Bernstein, and K. Ushimaru, Energy International, Inc.; H.B. Levinsky and D.L. Oostendorp, N.V. Nederlandse Gasunie, The Netherlands

5:10 **Upstream Interactions Between Two Laminar Premixed Methane Flames**
C.L. Chen and *S.H. Sohrab*, Northwestern University

CP21/Long Key Ballroom
Turbulence 5
Chair: Stewart Cant, UMIST, United Kingdom

4:30 **Direct Simulation of Turbulent Variable Density Premixed Flames**
Christopher J. Rutland and Songwei Zhang, University of Wisconsin, Madison

4:50 **Direct Numerical Simulation of Turbulent Diffusion Flames with Multi-step Chemistry**
Nedunchezhian Swaminathan and *Shankar Mahalingam*, University of Colorado, Boulder

5:10 **3D Direct Numerical Simulations of Turbulent Reactive Flows**
J.P. Chollet, R.J. Gathmann, Institut de Mecanique de Grenoble, France

5:30
Conference Adjourns

TRANSPORTATION

Official Carrier for Continental USA and Canada

American Airlines (logo) is the official carrier for this conference. In a special arrangement for this conference, you can fly to Tampa at a discounted rate from November 29 - December 7, 1991 inclusive.

For those attendees traveling from points in the United States, American Airlines is offering a 45% discount off regular day coach airfares. For those in Canada, the discount is 35%. Each rate requires seven (7) days advance purchase.

You may be able to obtain an even lower airfare. American Airlines also is offering a five percent (5%) discount off any published airfare (including First Class and Ultra Saver fares) for which you qualify, i.e., you must satisfy all rules and restrictions on the fares quoted. Discounts can range from 40% to 70% off regular coach fares.

To make reservations for either of the above discounted fares:

- Call the American Airlines Convention Desk at the toll free number 800-433-1790 seven days a week from 8:00 AM to 11:00 PM (EST). Be sure to mention the SIAM Account Number S07Z1CN. American Airlines will mail your ticket to your home or office.

- You may use your corporate or university travel agent to purchase your ticket. Your agent should call the American Airlines Convention Desk to make your reservation. Make sure your agent mentions the discounts and uses the SIAM Account Number: S07Z1CN.

From Outside Continental USA and Canada

There is no designated carrier from foreign countries to the United States as each country has its own rules and regulations for airfares.

Reminder: When available, you can save money by buying an APEX ticket, but you generally must purchase your ticket at least three weeks (21 days) in advance of your departure date and stay in the United States at least seven days but not longer than two months.

PUBLIC TRANSPORTATION

The airport is approximately 30 to 40 minutes from the hotel. There are two shuttle services available that run 24 hours a day and can be taken from outside the baggage claim areas of the airport. They are Limousine Incorporated and Airport Connection. Both van services run approximately $12.00 per trip. You can purchase a round trip ticket for $22.00.

There are a number of cab companies that service the airport. The average one-way cost from the airport to the hotel is $50.00.

Driving Directions from Tampa International Airport

When exiting the airport take 275 South to exit #4 which is the Pinellas Bay exit (approximately 20 minutes). Take Pinellas Bay to Gulf Blvd. (approximately 10 minutes). Turn right on Gulf Blvd., the hotel is on Gulf Blvd. two miles from the turn on the left.

Attractions within driving distance of the hotel

Busch Gardens - 45 minutes
Adventure Island - 45 minutes
Sea World, Disneys' Magic Kingdom and Epcot Center, MGM Studios and
   Pleasure Island - 2 hours
Cypress Garden - 1 1/2 hours
Salvador Dali Museum - 20 minutes
Ringling Museum - 50 minutes

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CAR RENTAL

Car Rental at the Airport
or On-site at TradeWinds Hotel

Avis Rent-a-Car is the official car rental agency for this conference. Attendees may pick up and return cars at any corporate Avis rental location throughout the state of Florida at no additional charge. Conveniently, attendees can pick cars up at the airport location and on-site at the hotel. The rates are subject to the conditions listed below. Should a special rate be offered during the time of this conference, Avis will extend this rate to you. The rates listed below are the maximum rates you can expect to pay.

Type of Car	Daily Rate	Weekly Rate
Subcompact	$23.90	$ 89.00
Intermediate .	$29.90	$129.00
Mini Van, Luxury or Convertible	$39.90	$199.00

Conditions for Car Rental

(1) Unlimited free miles

(2) Rates are valid from November 25 - December 11, 1991 inclusive and are available at the airport and on-site at the hotel. Cars do not have to be picked up and dropped off at the same location. You may rent a car at the airport and drop it off at the hotel or vice versa.

(3) You must be 21 years of age and have a valid U.S. or International Drivers License.

(4) You must have one of the following credit cards to rent a car: American Express, MasterCard, Visa, or Diner's Club.

(5) The prices quoted do not include refueling services, tax, optional collision and loss damage waiver (CDW and LDW), or optional personal accident insurance.

Reservations

We encourage you to make advanced reservations, as on-site availability cannot be guaranteed. Make reservations by calling **800-331-1600**. When making your reservations, be sure to give the SIAM Rate Code **AW022721.** You should also mention that you are attending the SIAM Conference on Combustion, December 2-4, 1991 in St. Petersburg, in order to receive the indicated rates. You must also specify if you will pick up the car at the airport or at the hotel.

TradeWinds Hotel
5500 Gulf Boulevard
St. Petersburg Beach, FL 33706
813-367-6461

Reservations: SIAM is holding a block of rooms at the TradeWinds Hotel on a first come first served basis at the specially discounted rates of $85.00 single, $95.00 double and $125.00 for a one or two bedroom suite. Please note that all rates are subject to an occupancy tax of 10%. These rooms will be held for our exclusive use until November 2, 1991, after which reservations will depend on availability. SIAM cannot guarantee any assistance in getting you a room at the hotel if you choose to make your reservations after the November 2nd deadline. A deposit in the amount of one night's room rate is required to confirm reservations. If you need to cancel your reservation, please do so 48 hours prior to the date of your arrival to avoid being penalized.

We urge you to make your reservations as soon as possible. You may do so by telephoning 813-367-6461 or by using the Hotel Reservation Form on the inside back page of this program (domestic mail only). When making reservations, you must identify yourself as an attendee at the SIAM Conference on Combustion to obtain the discounted rate.

Late Arrival Policy: If you plan to arrive after 6:00 PM you must inform the TradeWinds of your plans and guarantee your reservation with a credit card or check in the amount of one night's room rate. If you do not guarantee your room for late arrival and you arrive after 6:00 PM your room may be given to someone else.

Check In: Check-in time is 4:00 PM and check out is 11:00 AM.

Facilities: The TradeWinds guest rooms are housed in a six story contemporary design which features plenty of open outside areas. Thoughtful amenities such as a wet bar, refrigerator, coffee maker, (and, of course, a television and phone in the bathroom) are standard touches in every hotel room. Suites, with one or two bedrooms, offer a separate living area, fully-equipped kitchen and private balconies with spectacular views.

Recreation: The TradeWinds is located next to the warm waters of the Gulf of Mexico on seven miles of white sand. This offers limitless choices for leisurely activities such as sailboating, water trikes, kayaks, windsurfing, tennis, basketball, ping pong, bicycle rental, aerobics, and game rentals. Within a five- and ten-minute walk, you can find jet skiing and water skiing facilities. You can also find paddleboat rentals, four pools (one is enclosed), whirlpools, sauna, and a fitness center right at the TradeWinds. There are also daily scheduled activities throughout the hotel for children between the ages of three and early teens.

Restaurants and shopping: Within walking distance of the TradeWinds, there are many little shops and beach bars. At the TradeWinds, there are three locations where you can eat: the Palm Court, which serves breakfast and lunch then in the evening becomes the hotels' fine dining restaurant; the Flying Bridge, a beach bar that serves quick snacks and sandwiches; and Silas Dent, a contemporary restaurant located across the street that will let you charge to your hotel room.

Parking: There is complimentary parking to all hotel guests and those commuting to the conference.

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REGISTRATION INFORMATION

Please complete the Advance Registration Form on the inside back cover and return it in the envelope provided. We urge attendees to register in advance to take advantage of the lower registration fee. Advance registration must be received by November 25, 1991.

The registration desk will be open as listed below:

Sunday, December 1	6:00 PM - 9:00 PM
Monday, December 2	7:30 AM - 4:30 PM
Tuesday, December 3	8:00 AM - 4:30 PM
Wednesday, December 4	8:00 AM - 2:00 PM

Registration Fees

	SIAM Member	Non-Member	Student
Advance	$140	$170	$35
On-Site	$170	$210	$35

Notice

There will be no prorated fees. No refunds will be issued once the conference has started.

If SIAM does not receive your Advance Registration payment by November 25, 1991, you will be asked to give us a check or a credit card at the conference. We will not process either until we have ascertained that your registration payment has gone astray. In the event that we receive your payment after November 25, 1991, we will destroy your check or credit card slip.

Credit Cards

SIAM accepts VISA, MasterCard and American Express for the payment of registration fees and special functions. When you complete the Advance Registration Form, please be certain to indicate the type of credit card, the number, and the expiration date.

SIAM Corporate Members

Non-member attendees who are employed by the following institutions are entitled to the SIAM Member rate.

Aerospace Corporation
Amoco Production Company
AT&T Bell Laboratories
Bell Communications Research
Boeing Company
BP America
Cray Research, Inc.
E.I. du Pont de Nemours & Company
Eastman Kodak Company
Exxon Research and Engineering Company
General Motors Corporation
GTE Laboratories, Inc.
Hollandse Signaalapparaten B.V.

IBM Corporation
ICASE
IMSL, Inc.
Lockheed Corporation
MacNeal-Schwendler Corporation
Martin Marietta Energy Systems
Mathematical Sciences Research Institute
NEC Research Institute
Supercomputing Research Center, a division of Institute for Defense Analyses
Texaco Inc.
United Technologies Corporation

HOTEL RESERVATION FORM

Fourth International Conference on
Numerical Combustion

December 2-4, 1991
TradeWinds Hotel
St. Petersburg Beach, Florida 33706

PLEASE SEND ME A CONFIRMATION NOTICE

Specially discounted rooms are being held for our exclusive use until November 2, 1991. After that date reservations will depend on availability. Your reservation is not confirmed until acknowledged in writing by the hotel or verified by phone. When making reservations by phone, be certain to identify yourself as an attendee at the Fourth International Conference on Numerical Combustion. Telephone: 813-367-6461.

PLEASE PRINT

Name _____
      FIRST   MIDDLE

_____
      LAST

Phone _____

Address _____

City _____ State _____ Zip _____

Please reserve [ ] Single $85 [ ] Double $95

[ ] One bedroom suite $125 [ ] Two bedroom suite $125

Arrival Date _____ Arrival Time _____

Departure Date _____

I will share a room with _____

I am a [ ] Smoker [ ] Non-Smoker

I need a double room with [ ] 1 bed [ ] 2 beds

To make a reservation you must include a deposit in the amount of the first night's room rate.

I choose to pay by :* [ ] AMEX [ ] VISA [ ] MC [ ] Check

Credit Card No. _____

Exp. Date _____ Deposit $ _____

Signature _____

*Please enclose this form in an envelope and mail to Reservation:
TradeWinds Hotel, 5500 Gulf Blvd., St. Petersburg Beach, Florida 33706

siam

Society for Industrial and Applied Mathematics
6th Floor
3600 University City Science Center
Philadelphia, PA 19104-2688

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