

M A R C O S C H A O S

Department of Mechanical and Aerospace Engineering

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RESEARCH AND PROFESSIONAL INTERESTS

Combustion and Flame Phenomena, Energy, Alternative Fuels, Chemical Kinetics, Fluid Dynamics, Heat Transfer, Experimental Laser and Optical Techniques, Pollutant Emissions of Combustion Systems, Propulsion, Turbomachinery, Spectroscopy, Acoustics, Space Systems and Applications.

ACADEMIC DEGREES

- 2003 *Ph. D. Mechanical Engineering*, University of Central Florida, Orlando, FL
- Thermofluid Aerodynamic Systems Design and Engineering Track.
 - Dissertation: “A Planar Laser-Induced Fluorescence Study on the Effects of Unsteadiness and Fuel Lewis Number in Hydrogen Laminar Diffusion Flames”
- 1998 *B. S. Aerospace Engineering*, University of Central Florida, Orlando, FL

WORK/RESEARCH EXPERIENCE

- 2005 – Present **Princeton University**, Department of Mechanical and Aerospace Engineering
- *Associate Research Scholar*, Combustion & Fuels Research Laboratory (1/2007 – Present)
 - *Post-doctoral Research Associate*, Combustion & Fuels Research Laboratory (2005 – 12/2006)
Research: Development of chemical kinetic models for gasoline, diesel, and jet fuel surrogates; Flow reactor studies of conventional and alternative fuels as well as fundamental molecules (i.e. H₂, CO, CH₂O, etc.); Implementation of chemical kinetics in the modeling of practical combustion systems; Safety aspects of the hydrogen economy; Kinetics of microgravity droplet combustion; Collaboration with departmental faculty in studies of other fundamental aspects of flames (e.g. speed, ignition/extinction).
- 2000 – 2005 **University of Central Florida**, MMAE Department
- *Post-doctoral Research Fellow*, Combustion Laboratory (2004-2005)
 - *Graduate Research Assistant/Lab Manager*, Combustion Laboratory (2000-2004)
Research: Effect of thermal and mass transport on laminar diffusion flame properties (temperature, soot, NO_x emissions, lift-off, extinction); Laser diagnostics; Burning characteristics of micro-sized metal alloy particles; Acoustic detection and sizing of suspended particles.
 - *Instructor* (1999-2005)
 - *Teaching Assistant* (1998-2005)
 - *Undergraduate Research Assistant*, Supersonic Wind Tunnel
Research: Noise reduction and mixing in underexpanded swirling jets.
- 1997 – 1998 **Florida Space Institute**
- *Undergraduate Research Assistant*, PHOTON satellite

TEACHING EXPERIENCE (University of Central Florida)

EAS 3101 (Aerodynamics I)
EML 3034 (Modeling Methods in Aerospace and Mechanical Engineering)
EML 3303/EAS 3800 (Mechanical/Aerospace Engineering Measurements Laboratory)
EML 3701, EML 4703 (Fluid Mechanics I, II)
EAS 4300 (Aerothermodynamics of Propulsion Systems)
EML 5131 (Combustion)

HONORS AND AWARDS

Summa Cum Laude Graduate (4.0/4.0 GPA), 1998-2003.
College of Engineering Outstanding Dissertation Award Nominee, 2004.
Siemens-Westinghouse Power Corporation Doctoral Fellow, 2000-2003.
1st place, AIAA southeastern regional design competition, 1998.
MMAE Engineering Excellency Award, 1998.
MMAE Whalen Scholarship Award, 1998.

PUBLICATIONS

Refereed articles

- Westbrook, C.K., Pitz, W.J., Westmoreland, P.R., Dryer, F.L., Chaos, M., Oßwald, P., Kohse-Höinghaus, K., Cool, T.A., Wang, J., Yang, B., Hansen, N., and Kasper, T., "A Detailed Chemical Kinetic Mechanism for Oxidation of Four Small Alkyl Esters in Laminar Premixed Flames," *Proceedings of the Combustion Institute*, 32 (2009), in press.
- Mittal, G., Chaos, M., Sung, C.-J., and Dryer, F.L., "Dimethyl Ether Autoignition in a Rapid Compression Machine: Experiments and Chemical Kinetic Modeling," *Fuel Processing Technology*, in press.
- Mohammed, H., Chaos, M., Chen R.-H., and Xu, F., "Effects of Dilution on Soot Formation in Laminar C₂H₄ Diffusion Flames," *Combustion Science and Technology*, in press.
- Chaos, M. and Dryer, F.L., "Syngas Combustion Kinetics and Applications," *Combustion Science and Technology*, 180 (2008) 1051-1094.
- Chen, R.-H., Chaos, M., and Haddad, G.F., "Analysis of Dilute Aerosol Flow and Noise Generation in an Acoustic Transducer," *Journal of Aerosol Science*, (2008) doi: 10.1016/j.jaerosci.2008.01.004, in press.
- Dryer, F.L. and Chaos, M., "Ignition of Syngas/Air and Hydrogen/Air Mixtures at Low Temperatures and High Pressures: Experimental Data Interpretation and Kinetic Modeling Implications," *Combustion and Flame*, 152 (2008) 293-299.
- Zhao, Z., Chaos, M., Kazakov, A., and Dryer, F.L., "Thermal Decomposition Reaction and a Comprehensive Kinetic Model of Dimethyl Ether," *International Journal of Chemical Kinetics*, 40 (2008) 1-18.
- Chaos, M., Kazakov, A., Zhao, Z., and Dryer, F.L., "A High-Temperature Chemical-Kinetic Model for Primary Reference Fuels," *International Journal of Chemical Kinetics*, 39 (2007) 399-414.
- Dryer, F.L., Chaos, M., Zhao, Z., Stein, J.N., Alpert, J.Y., and Homer, C.J., "Spontaneous Ignition of Pressurized Releases of Hydrogen and Natural Gas into Air," *Combustion Science and Technology*, 179 (2007) 663-694.
- Li, J., Zhao, Z., Kazakov, A., Chaos, M., Dryer, F.L., and Scire, J.J., Jr., "A Comprehensive Kinetic Mechanism for CO, CH₂O, CH₃OH Combustion," *International Journal of Chemical Kinetics*, 39 (2007) 109-136.
- Chen, R.-H., Chaos, M., and Kothawala, A., "Lewis Number Effects in Laminar Diffusion Flames Near and Away from Extinction," *Proceedings of the Combustion Institute*, 31 (2007) 1231-1237.
- Chen, Z., Qin, X., Ju, Y., Zhao, Z., Chaos, M., and Dryer, F.L., "High Temperature Ignition and Combustion Enhancement by Dimethyl Ether Addition to Methane-air Flames," *Proceedings of the Combustion Institute*, 31 (2007) 1215-1222.

- Chen, R.-H., Suryanarayana, C., and Chaos, M., "Combustion Characteristics of Mechanically Alloyed Ultrafine-Grained Al-Mg Powders," *Advanced Engineering Materials*, 8 (2006) 563-567.
- Kazakov, A., Chaos, M., Zhao, Z., and Dryer, F.L., "Computational Singular Perturbation Analysis of Two-Stage Ignition of Large Hydrocarbons," *Journal of Physical Chemistry A*, 110 (2006) 7003-7009.
- Turek, L.J., Dawson, R.W., Chaos, M., and Chen, R.-H., "An Investigation of the Effect of Swirl Vane Angle on Fuel Concentration and Velocity Fields in Gas Turbine Mixers," ASME paper GT2005-68152.
- Chen, R.-H., Kothawala, A., Chaos, M., and Chew, L. P., "Schmidt Number Effects on Laminar Jet Diffusion Flame Lift-off," *Combustion and Flame*, 141 (2005) 469-472.
- Chaos, M., Haddad, G. F., and Chen, R.-H., "Airborne Particle Detection Using Acoustic Transducers," *WIT Transactions on Ecology and the Environment*, 82 (2005) 435-444.
- Chaos, M., Chen, R. -H., Welle, E. J., and Roberts, W. L., "Fuel Lewis Number Effects in Unsteady Burke-Schumann Hydrogen Flames," *Combustion Science and Technology*, 177 (2005) 75-88.
- Chaos, M. and Chen, R. -H., "An Experimental Study of Pulsating Instability in Near-limit Laminar Nonpremixed Flames," *Combustion Science and Technology*, 176 (2004) 1195-1215.
- Chen, R. -H., Chaos, M., Haddad, G. F., and Mills, T. E., "Effects of Vortex Shedding by Particles in Acoustical Transducers," *Journal of Sound and Vibration*, 270 (2004) 473-479.

Conferences and reports

- Haas, F.M., Chaos, M., and Dryer, F.L., "Oxidation of PRF-Ethanol Blends: Kinetic Modeling at Low and Intermediate Temperatures," *Spring Meeting of the American Chemical Society*, New Orleans, LA, April 6-10, 2008.
- Mittal, G., Chaos, M., Sung, C.-J., and Dryer, F.L., "A Rapid Compression Machine Study of Dimethyl Ether Autoignition," Paper A-13, *Fall Technical Meeting of the Eastern States Section of the Combustion Institute*, Charlottesville, VA, October 21-25, 2007.
- Chaos, M., Zhao, Z., Kazakov, A., Gokulakrishnan, P., Angioletti, M., and Dryer, F. L., "A PRF+Toluene Surrogate Fuel Model for Simulating Gasoline Kinetics," Paper E26, *5th US Combustion Meeting*, San Diego, CA, March 25-28, 2007.
- Li, J., Kazakov, A., Chaos, M., and Dryer, F. L., "Chemical Kinetics of Ethanol Oxidation," Paper C26, *5th US Combustion Meeting*, San Diego, CA, March 25-28, 2007.
- Zhao, Z., Chaos, M., Kazakov, A., Gokulakrishnan, P., Angioletti, M., and Dryer, F. L., "Fuel Chemistry Models for Simulating Gasoline Kinetics in Internal Combustion Engine Applications," Work-in-Progress 2C-27, *Thirty-first International Symposium on Combustion*, Heidelberg, Germany, August 6-11, 2006.
- Chaos, M., Zhao, Z., Kazakov, A., and Dryer, F. L., "An Experimental and Kinetic Study of Acetone Pyrolysis and Oxidation in a Flow Reactor," Work-in-Progress 2E-04, *Thirty-first International Symposium on Combustion*, Heidelberg, Germany, August 6-11, 2006.
- Chaos, M., Kazakov, A., Zhao, Z. and Dryer, F. L., "Model Development and Reduction Methods for High-Temperature Large Alkane Molecule Kinetics," Work-in-Progress 2E-15, *Thirty-first International Symposium on Combustion*, Heidelberg, Germany, August 6-11, 2006.
- Kazakov, A., Chaos, M., Zhao, Z., and Dryer, F. L., "Computational Singular Perturbation Analysis of *n*-Heptane Two-Stage Ignition," *Fall Technical Meeting of the Eastern States Section of the Combustion Institute*, Orlando, FL, November 13-16, 2005.

Chaos, M., Kazakov, A., Zhao, Z., Dryer, F. L., and Zeppieri, S. P., "Reduced High-Temperature Mechanisms for Large Paraffins – *n*-Hexadecane," *Fall Technical Meeting of the Eastern States Section of the Combustion Institute*, Orlando, FL, November 13-16, 2005.

Chaos, M. and Chen, R.-H., "Lewis Number Effects on the Extinction of Counterflow Diffusion Flames," *Fall Technical Meeting of the Eastern States Section of the Combustion Institute*, Orlando, FL, November 13-16, 2005.

Dryer, F. L., Kazakov, A., Chaos, M., and Zhao, Z., "Fuel Chemistry Models for Simulating Gasoline Kinetics in Internal Combustion Engine Applications," contract report to HONDA R&D Co., Ltd., Japan (2005).

Chaos, M., Kazakov, A., Zhao, Z., Dryer, F. L., and Zeppieri, S. P., "High Temperature Compact Mechanism Development for Large Alkanes: *n*-Hexadecane," Poster C14, *6th International Conference on Chemical Kinetics*, Gaithersburg, MD, July 25-29, 2005.

Mohammed, H., Chaos, M., Chen, R.-H., and Xu, F., "Effects of Dilution on Soot Formation in Laminar C₂H₄ Diffusion Flames," *20th International Colloquium on the Dynamics of Explosions and Reactive Systems*, Montreal, Canada, July 31-August 5, 2005.

Turek, L. J., Dawson, R. W., Chaos, M., and Chen, R. -H., "An Investigation of the Effect of Swirl Vane Angle on Fuel Concentration and Velocity Fields in Gas Turbine Mixers," *ASME Turbo Expo*, Reno-Tahoe, NV, June 6-9, 2005.

Chaos, M., Haddad, G. F., and Chen, R.-H., "Airborne Particle Detection Using Acoustic Transducers," *13th International Conference on Modelling, Monitoring and Management of Air Pollution*, Córdoba, Spain, May 16-18, 2005.

Chaos, M. and Chen, R.-H., "Lewis Number Effects on the Extinction of Diluted CH₄ and C₃H₈ Counterflow Diffusion Flames," *Fourth Joint Meeting of the U.S. Sections of the Combustion Institute*, Philadelphia, PA, March 20-23, 2005.

Chaos, M., Haddad, G. F., and Chen, R. -H., "Implementation of an Automatic Particle Counter Using an Acoustic Transducer," in *KSC Research & Technology Report 2004*, NASA Technical Memorandum 2004-211535, pp. 10-12.

Suryanarayana, C., Chen, R. -H., Singh, D., Mertus, L., and Chaos, M., "Mechanical Alloying and Burning of Al-Mg Powder Particles," *Proceedings of the MRS Fall Meeting 03*, Symposium AA, Boston, MA, December 2003.

Chaos, M., Chen, R. -H., Welle, E. J., and Roberts, W. L., "Effects of Unsteadiness and Fuel Lewis Number on Burke-Schumann Type Hydrogen Diffusion Flames," Work-in-Progress 5-16-1383, *Twenty-Ninth International Symposium on Combustion*, Sapporo, Japan, July 2002.

COMPUTER SOFTWARE EXPERIENCE

Windows, DOS, and UNIX operating systems, FORTRAN, HTML coding, extensive MS Office experience (Word, Excel, PowerPoint), Matlab, Mathematica, Mathcad, LabView, IPLab, I-DEAS Masters Series, AutoCAD, CHEMKIN.

RESEARCH AND LABORATORY SKILLS

Optical component setup and operation of high power lasers, Laser Doppler Velocimetry (LDV), Planar Laser-Induced Fluorescence (PLIF), infrared gas detection, FTIR, chemiluminescence analyzers, Schlieren visualization, digital image processing, wind tunnel operation (subsonic and supersonic), gas chromatography, particle detection, computerized signal acquisition.

LANGUAGES

Fluent Spanish, English, Italian, and Catalan written and spoken. Reading knowledge of French.