

Aug, 2012

DEBORAH ANN LEVIN

EDUCATION

State University of New York at Stony Brook, B. S., Chemistry, 1974

California Institute of Technology, Ph. D., Chemistry, 1979

Ph. D. Thesis: “Ab Initio Calculations of Processes in Low Energy Electron-Molecule Scattering,” California Institute of Technology, June 1979, Thesis advisor, Prof. B. V. McKoy

EMPLOYMENT

July, 2007 – Present	Professor,
August, 2000–June 2007	Associate Professor
	Department of Aerospace Engineering
	The Pennsylvania State University
	University Park, PA 16802
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	dalevin@psu.edu
May, 1998–Aug. 2000	Research Professor and lecturer,
	Department of Chemistry,
	George Washington University
	Washington, DC 20052
1979–May, 1998	Institute for Defense Analyses (IDA), Science & Technology and Systems Evaluation Divisions, Research Staff Member, Task Leader.

NARRATIVE STATEMENT

Dr. Deborah Levin joined the faculty of Penn State University as Associate

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Professor in the Fall of 2000 following two years as a Research Professor at George Washington University and nineteen years as a research staff member at the Institute for Defense Analyses (IDA). At IDA she began her research in modeling and simulation of chemically reacting, two-phase flows applied to the design of optical instruments for small rocket and satellite space experiments and post-mission data interpretation.

Since coming to Penn State, Dr. Levin has taught courses in Spacecraft Environmental Effects, an elective in the Department of Aerospace Engineering for seniors and graduate students, Mechanics of Fluids, a course for Engineering Science majors, Aerodynamics I and II and Aerospace Analysis, the junior year courses in incompressible and viscous and compressible flows and numerical and analytic solutions for Aerospace Engineering majors, and the Physics of Gases for Aerospace and Mechanical Engineer graduate students that covers the kinetics, statistical mechanics, and quantum mechanics necessary to understand optical spectra of high-temperature flows. During her two years at GWU she taught General Chemistry, a course for science majors. She is currently supervising, one M.S. students six Ph.D. students, and two postdoctoral fellows. She has graduated six MS and five Ph.D. students.

Dr. Levin's research combines topics in aerospace engineering and physical chemistry. Her research spans the general categories of modeling space experiments, space environments, microfluidics, micropropulsion, thermal protection materials, and plasma processes. The direct simulation Monte Carlo (DSMC) method is the primary gas dynamic technique used in her research to calculate non-equilibrium, transitional flows. In addition, different multi-scale approaches have been developed to extend the applicability to DSMC to near-continuum/continuum flows. Molecular dynamics is utilized to develop accurate physical, fine-grained models particularly for chemical reactions and two-phase cluster flows.

In the modeling of space experiments, her research has helped to quantitatively identify the electronically-excited NO₂ visible radiation as the dominant mechanism of spacecraft glow, as well as to numerically simulate OH and NH ultraviolet radiation observed from the Mir space station experiments. Using quasi-classical trajectory methods, she has been able to replace the usual DSMC semi-empirical chemical model with physically realistic collisional and chemical cross sections for selected chemical reactions with low-earth orbit reactive atomic oxygen. Her research has also extended the DSMC method to the modeling of homogeneous condensation in supersonic plume expansions, an important component of space-plume signatures as well as materials processing. Her most recent project has involved modeling the high-altitude strongly

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ionized hypersonic flow and radiation from the Stardust Sample Return Capsule, the fastest vehicle to survive reentry into earth's atmosphere.

In addition, she has developed projects in applied research areas related to the modeling of MEMS micro-thruster propulsion device performance and materials survivability in atomic oxygen rich environments. Her first 3-D simulations of MEMS microthruster gas flows show that the gas-surface interaction model dominates the physics of these device flows and her first coupled DSMC and heat transfer calculations demonstrate that the thrust and nozzle survivability can be predicted for different material cooling strategies. Due to the multiple length scales in these problems, computationally more efficient forms of DSMC based on collision-limiter techniques have been developed. These approaches are being applied to the modeling of crack propagation in reinforced carbon-carbon materials used on the Shuttle wing leading edges and nose and charring ablator class of materials for planetary exploration.

Dr. Levin serves the Pennsylvania State University with membership on several committees including those at the departmental and university levels. At the national level she continues to serve the profession primarily through her participation on the AIAA Plasmadynamics and Lasers Technical committee, involvement in conference organization and session chairing, and as a reviewer for various AIAA and APS journals. She is an associated editor for the Journal of Thermophysics and Heat Transfer. She supports DoD and NASA government agencies and industry through contracts and grants that rely on her expertise in modeling chemically reacting transitional flows.

PUBLICATIONS

1. Refereed Journal Publications:

P. M. Johnson and D. A. Levin, "A Dependence of Measured Phosphorescence Lifetimes upon Excitation Wavelength," *Molecular Photochemistry*, Vol. 6, p. 263, 1974.

D. A. Levin, T. N. Rescigno, and V. McKoy, "Discrete-Basis-Set Approach to the Minimum-Variance Method in Electron Scattering," *Physical Review A*, Vol. 16, p. 157, 1977.

D. A. Levin, A. W. Fliflet, M. Ma, and V. McKoy, "Gaussian Matrix Elements of the Free-Particle Green's Function," *Journal of Computational Physics*, Vol. 28, p. 416, 1978.

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- A. W. Fliflet, D. A. Levin, M. Ma, and V. McKoy, "Discrete-Basis-Set Calculations for e^- -N₂ Scattering Cross Sections in the Static-exchange Approximation," *Physical Review A*, Vol. 17, p. 160, 1978.
- D. A. Levin, A. W. Fliflet, and V. McKoy, "Low Energy Rotational and Vibrational-rotational Excitation Cross Sections for H₂ by Electron Impact," *Physical Review A*, Vol. 20, p. 491, 1979.
- D. A. Levin, A. W. Fliflet, and V. McKoy, "Variationally Corrected Discrete Basis Set Calculation for e^- -CO Scattering in the Static-Exchange Approximation," *Physical Review A*, Vol. 21, p. 1202, 1980.
- S. N. Dixit, D. A. Levin, and B. V. McKoy, "Resonant Enhanced Multiphoton Ionization Studies in Atomic Oxygen," *Physical Review A*, Vol. 37, p. 4220, 1988.
- D. A. Levin, R. J. Collins, and G. V. Candler, "Computations for Support Design of Measurements of Radiation from Low Velocity Shock Heated Air," *Journal of Thermophysics and Heat Transfer*, Vol. 5, p. 463, 1991.
- C. T. Christou and D. A. Levin, "Analysis of Laser Backscattering from Solid Fuel Rocket Plumes," *AIAA Journal*, Vol. 29, No. 8, pp. 1259–1265, August 1991.
- D. A. Levin, R. T. Loda, G. V. Candler, and C. Park, "Theory of Radiation from Low Velocity Heated Air," *Journal of Thermophysics and Heat Transfer*, Vol. 7, p. 269, 1993.
- C. T. Christou, R. T. Loda, and D. A. Levin, "Simulation of Range- Resolved DIAL Measurements on In-Flight Rocket Plumes," *Journal of Thermophysics and Heat Transfer*, Vol. 7, p. 233, 1993.
- P. W. Erdman, E. C. Zipf, P. Espy, C. Howlett, D. A. Levin, R. Loda, R. J. Collins, and G. V. Candler, "Flight Measurements of Low Velocity Bow Shock Ultraviolet Radiation," *Journal of Thermophysics and Heat Transfer*, Vol. 7, p. 37, 1993.
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- P. W. Erdman, E. C. Zipf, P. Espy, C. Howlett, C. T. Christou, D. A. Levin, R. J. Collins, and G. V. Candler, "In-situ Measurements of UV Plume Radiation from the Bow Shock Ultraviolet 2 Rocket Flight," *Journal of Thermophysics and Heat Transfer*, Vol. 7, p. 704, 1993.

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- G. V. Candler, D. A. Levin, R. J. Collins, P. W. Erdman, E. Zipf, P. Espy, and C. Howlett, "Comparison of Theory with Plume Radiance Measurements from the Bow Shock Ultraviolet 2 Rocket Flight," *Journal of Thermophysics and Heat Transfer*, Vol. 7, p. 709, 1993.
- P. W. Erdman, E. C. Zipf, P. Espy, C. Howlett, D. Levin, R. Collins, and G. Candler, "Measurements of Ultraviolet Radiation from a 5 km/sec Bow Shock," *Journal of Thermophysics and Heat Transfer*, Vol. 8, p. 441, 1994.
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- D. Levin, G. Candler, R. Collins, C. Howlett, and E. Whiting, "Comparison of Theory with Atomic Oxygen 130.4 nm Radiation Data from the Bow Shock Ultraviolet 2 Rocket Flight," *Journal of Thermophysics and Heat Transfer*, Vol. 9, p. 629, 1995.
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- I. Sohn, Z. Li, and D. A. Levin, "Effect of Non-local VUV Radiation on a Hypersonic Non-equilibrium Flow," AIAA Paper No. 2011-533, AIAA 49th Aerospace Sciences Meeting, 4-7 Jan 2011, Orlando, Florida.
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- R. Kumar, E. V. Titov, D. A. Levin, and B. P. Anderson, "Development and Application of a Charring Ablator Thermal Response Model," AIAA Paper No. 2011-3785, 42nd AIAA Thermophysics Conference, 27 - 30 June 2011, Honolulu, Hawaii.
- Z. Li, I. Sohn, and D. Levin, "DSMC Modeling of Vibration-Translational Relaxation of Molecular Nitrogen in Hypersonic Reentry Flows," AIAA Paper No. 2011-3131, 42nd AIAA Thermophysics Conference, 27 - 30 June 2011, Honolulu, Hawaii.
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- A. Borner, Z. Li and D. Levin, "Ionic Liquid Electrospray Modeling using Molecular Dynamics," AIAA Paper No. 2011-5524, 47th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, 31 July - 03 August 2011, San Diego, California.
- Z. Li, I. Sohn, and D. A. Levin, "DSMC Modeling of Vibration-Translational Relaxation of Molecular Nitrogen in Hypersonic Reentry Flows," DSMC2011 Workshop, Santa Fe, New Mexico, USA, September 26 - 28, 2011.
- R. Dhariwal, R. Kumar, D.A. Levin, D.B. Goldstein, P.L. Varghese, and L.M. Trafton, "Modeling and Simulation of Near-field Enceladus Plumes from Tiger Stripe Fractures using a Collision-limiter Condensation Model," AIAA Paper No. 2012-226, 50th AIAA Aerospace Sciences Meeting, 9-12 January, 2012, Nashville, Tennessee.
- R. Kumar, A. Borner, Z. Li, and D. Levin, "Electrospray Simulation in a Colloid Thruster using Particle-in-Cell (PIC) Approach," AIAA Paper No. 2012-788, 50th AIAA Aerospace Sciences Meeting, 9-12 January, 2012, Nashville, Tennessee.
- Z. Li, I. Sohn, and D. Levin, "DSMC Modeling of NO Formation for Simulation of Radiation in Hypersonic Flows," *AIAA Paper No. 2012-0228*, 50th AIAA Aerospace Sciences Meeting, 9-12 January, 2012, Nashville, Tennessee.
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- A. Borner, D. Levin, and Z. Li, "Study of Homogeneous Condensation of Water in Supersonic Expansions using Molecular Dynamics," "AIAA-2012-229, 50th AIAA Aerospace Sciences Meeting, 9-12 January, 2012, Nashville, Tennessee.
- N. Parsons, D. Levin, and A. van Duin, "Analysis of Molecular Dynamics Based Chemistry Models for DSMC Simulations of the atmosphere of Io," AIAA 43rd Thermophysics Conference, AIAA-2012-2994, June 2012, New Orleans, LA.
- P. Wang, A. Borner, Z. Li, and D. Levin, "An Advanced Particle-in-Cell (PIC) Approach for Electrospray Simulation in a Colloid Thruster using Molecular Dynamics Simulation Results," 43rd AIAA Thermophysics Conference, 25-28 June 2012, New Orleans, LA, *AIAA Paper No. 2012-2993*.
- Z. Li, I. Sohn, and D. Levin, "State Specific Vibrational Relaxation and Dissociation Models for Nitrogen in Shock Wave Regions," *43rd AIAA Thermophysics Conference, New Orleans, LA, 25 - 28 Jun 2012, AIAA Paper 2012-2996*.
- T. Zhu, D. Levin, P. Setlow, and C. Neely, "Deactivation Analysis of Spores in a High Temperature Gas Using a Coupled Water Diffusion and Heat Transfer Model," *43rd AIAA Thermophysics Conference, New Orleans, LA, 25 - 28 Jun 2012, AIAA Paper 2012-2878*.
- A. Borner, Z. Li, and D. Levin, "Modeling of an Ionic Liquid Electrospray using a Molecular Dynamics Model," *48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, AIAA 2012-4291, Atlanta, GA*.

AWARDS

Co-recipient of the 2010 AIAA David Weaver Best Student Paper Award of the AIAA Thermophysics Technical Committee entitled, "Thermo-structural Studies of Spores Subjected to High Temperature Gas Environments."

Co-recipient of the 2009 AIAA David Weaver Best Student Paper Award of the AIAA Thermophysics Technical Committee for AIAA 2008-4420 entitled, "Kinetic Nucleation Model for Free-Expanding Water Condensation Plume Simulations."

AIAA Certificate of Merit for the purpose of promoting technical and scientific excellence presented to D. A. Levin and S. F. Gimelshein, for the outstanding paper titled, "Modeling of OH Vibrational Distributions Using Molecular Dynamics with Direct Simulation Monte Carlo Method," 35th AIAA Thermophysics Conference, Anaheim, California, June 12, 2001.

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2006 Penn State Engineering Society Outstanding Research Award.

PROFESSIONAL ACTIVITIES

1. Member of the AIAA and the Plasmadynamics and Lasers Technical Committee and present chair (June 2007-May2009). AIAA Associate Fellow, January 2004.
2. Associate editor and reviewer for the *Journal of Thermophysics and Heat Transfer*, *AIAA Journal*, the *Journal of Spacecraft and Rockets*, and *Physics of Fluids*, ASME, International Mechanical Engineering Congress and Exposition, New Orleans, Louisiana, November 17–22, 2002.
3. Chair and Editor of the 27th International Symposium on Rarefied Gas Dynamics, July 11-16, 2010, Asilomar conference Grounds, Ca.
4. Member of the Rarefied Gas Dynamics International Advisory Committee, July 2010 to present.
5. Participation in the Jet Propulsion Laboratory's New Millennium Program's Space Technology 7 (ST7) system validation flight experiment program's pre-phase A study team for Aerocapture, January 18, 2001.
6. Participation as deputy science team leader for the Skipper Satellite, launched in December 1995. The satellite project was a fully integrated endeavor between American and Russian scientists and engineers. The position involved supervising the development of science instrument scripts, computer software to automate script development, data analyses, and the integration of the science objectives into the mission. In coordination with researchers from Cornell and the University of Minnesota, participation included the preparation of pre-flight radiance predictions.
7. Organizer and Chair of the Plasmadynamics and Lasers Technical Committee Sessions for the AIAA 36th Aerospace Sciences Meeting, January 1998. Session chair for various Aerospace Sciences Meetings, Thermophysics, and Plasmadynamics Conferences.
8. Organizer and session chair for the 2002 International Symposium of Rarefied Gas Dynamics Meeting, Whistler, Canada.