ACME

Advanced Combustion via Microgravity Experiments

PUBLICATIONS TO DATE

As of January 2016

The ACME publications and presentations are listed by experiment after the listing for general material on the project as a whole.

ACME (general to the project) – ***as of January 2016***

Conference Papers (full papers, acceptance based on abstract)

1. T.F. O'Malley, W.A. Sheredy, and D.P. Stocker, "Combustion Research on the International Space Station," 59th International Astronautical Congress 2008, Vol. 2, pp. 756-766 (2008).
2. D.P. Stocker, F. Takahashi, J.M. Hickman, and A.C. Suttles, "Gaseous Non-Premixed Flame Research Planned for the International Space Station," Spring Technical Meeting of the Central States Section of the Combustion Institute, Tulsa, OK, 16–18 March, 2014.

Conference Presentations and Posters (only abstract required)

1. D.P. Stocker, F. Takahashi, P.V. Ferkul, and J.M. Hickman, "Gaseous Laminar Diffusion Flames for the Combustion Integrated Rack," 28th Annual Meeting of the American Society for Gravitational and Space Research, New Orleans, LA, Nov. 28 to Dec. 2, 2012.
2. D.P. Stocker, F. Takahashi, and J.M. Hickman, "Burner-Stabilized Gaseous Flames for the Combustion Integrated Rack," 29th Annual Meeting of the American Society for

Gravitational and Space Research and 5th International Symposium for Physical Sciences in Space, Orlando, FL, 3-8 Nov., 2013.

3. D.P. Stocker, F. Takahashi, J.M. Hickman, and A.C. Suttles, "Advanced Combustion via Microgravity Experiments: Planned International Space Station Research on Gaseous Flames," Work in Progress Poster, 35th International Symposium on Combustion, San Francisco, CA, 3-8 Aug., 2014.

Burning Rate Emulator (BRE) *– as of January 2016*

Refereed Journal Articles

3. Y. Zhang, M. Kim, P.B. Sunderland, J.G. Quintiere, J. de Ris, *A Burner to Emulate Condensed Phase Fuels*, Experimental Thermal and Fluid Science, accepted.
2. Y. Zhang, M. Kim, H. Guo, P.B. Sunderland, J.G. Quintiere, J. deRis, D.P. Stocker, *Emulation of Condensed Fuel Flames with Gases in Microgravity*, Combustion and Flame 162 (2015) 3449-3455.
1. Y. Zhang, M.J. Bustamante, M.J. Gollner, P.B. Sunderland, J.G. Quintiere, *Burning on Flat Wicks at Various Orientations*, Journal of Fire Sciences 32 (2014) 52-71.

Conference Proceedings and Posters

10. A. Markan, P.B. Sunderland, J.G. Quintiere, J. DeRis, D.P. Stocker, *A Burning Rate Emulator (BRE) for Study in Microgravity*, Abstract, ASGSR, Arlington VA, 2015.
9. Y. Zhang, M. Kim, P.B. Sunderland, J.G. Quintiere, J. de Ris, *A Burner to Emulate Condensed Phase Fuels*, Ninth Mediterranean Combustion Symposium, Rhodes, Greece, 12 pp. (2015).
8. Y. Zhang, M. Kim, P.B. Sunderland, J.G. Quintiere, J. DeRis, *A Burning Rate Emulator for Study in Microgravity*, American Society of Space and Gravitational Research, Abstract, Pasadena (2014).
8. Y. Zhang, M. Kim, P.B. Sunderland, J.G. Quintiere, J. deRis, D.P. Stocker, F. Takahashi, P.V. Ferkul, *A Burning Rate Emulator for Microgravity Studies*, Poster, International Symposium on Combustion, San Francisco (2014).
7. M.J. Bustamante, Y. Zhang, K.T. Dotson, P.B. Sunderland, J.G. Quintiere, *Burning on Flat Wicks at Various Orientations*, Proceedings of the Seventh International Seminar on Fire and Explosion Hazards, D. Bradley, G. Makhviladze, V. Molkov, P. Sunderland, F. Tamanini, Eds., Providence (2013), 10 pp.
6. Y. Zhang, M.J. Bustamante, K.T. Dotson, P.B. Sunderland, J.G. Quintiere, *A Gas Burner*

to Emulate Condensed-Phase Burning, Proceedings of the Seventh International Seminar on Fire and Explosion Hazards, D. Bradley, G. Makhviladze, V. Molkov, P. Sunderland, F. Tamanini, Eds., Providence (2013), 9 pp.

5. Y. Zhang, M.J. Bustamante, P.B. Sunderland, J.G. Quintiere, P. Ferkul, *A Burning Rate Emulator for Microgravity Fire Safety*, Poster, Seventh International Seminar on Fire and Explosion Hazards, Providence (2013).
4. Y. Zhang, M.J. Bustamante, P.B. Sunderland, J.G. Quintiere, P. Ferkul, *A Burning Rate Emulator for Study in Microgravity*, Eighth U.S. National Combustion Meeting, Salt Lake City (2013) 14 pp.
3. M.J. Bustamante, K.T. Dotson, P.B. Sunderland, J.G. Quintiere, *A Tale of Seven Flames*, Art Poster, Central States Section of the Combustion Institute, Dayton (2012).
2. M.J. Bustamante, K.T. Dotson, Y. Zhang, P.B. Sunderland, J.G. Quintiere, *Laminar Burning of Flat Diffusion Flames at Various Orientations*, Central States Section of the Combustion Institute, Dayton (2012) 15 pp.
1. K.T. Dotson, M.J. Bustamante, P.B. Sunderland, J.G. Quintiere, *Laminar Burning on Flat Wicks at Various Orientations*, 7th U.S. National Combustion Meeting, Atlanta (2011) 5 pp.

Theses

2. Kim, Matt, *Measurement of Heat Flux in Burning Rate Emulator*, M.S. Thesis, Dept. of Fire Protection Engineering, expected Dec. 2014.
1. Bustamante, Michael J., *Experimental Investigation of Liquid and Gas Fueled Flames Towards the Development of a Burning Rate Emulator (BRE) for Microgravity Applications*, M.S. Thesis, Dept. of Fire Protection Engineering, 91 pp., Aug. 2012.

Coflow Laminar Diffusion Flame (CLD Flame) *– as of Oct. 2015*

Note that this section includes publications, presentations, etc. with results from the CLD Flame precursor, Structure & Liftoff In Combustion Experiment (SLICE), which was conducted on the International Space Station (ISS) in early 2012. Papers, etc. which include ISS results from the SLICE experiment have been identified.

Peer-Reviewed Journal Papers

1. S.B. Dworkin, B.C. Connelly, A.M. Schaffer, M.B. Long, M.D. Smooke, M.P. Puccio, B. McAndrews and J.H. Miller, "Computational and Experimental Study of a Forced, Time-Dependent, Methane-Air Coflow Diffusion Flame," *Proc. Comb. Inst.*, **31**, 971-978 (2007).

2. S. B. Dworkin, A.M. Schaffer, B.C. Connelly, M.B. Long and M.D. Smooke, M.A. Puccio, B. McAndrew, and J.H. Miller, "Measurements and Calculations of Formaldehyde Concentrations in a Methane/N2/Air, Non-Premixed Flame: Implications for Heat Release Rate," *Proc. Comb. Inst.,* **32,** 1311–1318 (2009).
3. B.C. Connelly, M.B. Long, M.D. Smooke, R.J. Hall, and M.B. Colket, "Computational and Experimental Investigation of the Interaction of Soot and NOx in Coflow Diffusion Flames," *Proc. Comb. Inst.,* **32,** 777–784 (2009).
4. B.C. Connelly, B.A.V. Bennett, M.D. Smooke and M.B. Long, "A Paradigm Shift in the Interaction of Experiments and Computations in Combustion Research," *Proc. Comb. Inst.,* **32,** 879–886 (2009).
5. S.B. Dworkin, J.A. Cooke, B.A.V. Bennett, B.C. Connelly, M.B. Long, M.D. Smooke, R.J. Hall and M.B. Colket, "Distributed-memory parallel computation of a forced, time-dependent, sooting, ethylene/air coflow diffusion flame," *Combustion Theory and Modelling*, **13**, 795 - 822 (2009).
6. P.B. Kuhn, B. Ma, B.C. Connelly, M.D. Smooke, and M.B. Long, "Soot and Thin-filament Pyrometry Using a Color Digital Camera," *Proc. Comb. Inst.,* **33**, 743- 750 (2011).
7. M.B. Long, "Imaging Flames: From advanced laser diagnostics to snapshots," in *Optical Processes in Microparticles and Nanostructures*, A. Serpengüzel and A.W. Poon, Editors. 2011, World Scientific.
8. J.D. Herdman, B.C. Connelly, M.D. Smooke, M.B. Long and J.H. Miller, "A comparison of Raman signatures and laser-induced incandescence with direct numerical simulation of soot growth in non-premixed ethylene/air flames," *Carbon*, **49**, 5298-5311 (2011).
9. B. Ma and M.B. Long, "Absolute light calibration using S-type thermocouples," *Proc. Combust. Inst.,* **34**, 3531–3539 (2013).
10. B. Ma, G. Wang, G. Magnotti, R. S. Barlow and M. B. Long, "Intensity-ratio and color-ratio thin-filament pyrometry: Uncertainties and accuracy," *Combust. Flame*, **161**(4), 908–916 (2014).
11. B. Ma and M.B. Long, "Combined soot optical characterization using 2-D multi-angle light scattering and spectrally resolved line-of-sight attenuation and its implication on soot color-ratio pyrometry," Applied Physics B, **117**(1), 287-303 (2014).

Includes ISS Results from SLICE

12. B. Ma, S. Cao, D. Giassi, D.P. Stocker, F. Takahashi, B.A.V. Bennett, M.D. Smooke, and M.B. Long, "An experimental and computational study on soot formation in a coflow jet flame under microgravity and normal gravity," *Proc. Combust. Inst.,* **35**, 839-846 (2015).
13. S. Cao, B. Ma, B.A.V. Bennett, D. Giassi, D.P. Stocker, F. Takahashi, M.B. Long, and M.D. Smooke, "A computational and experimental study of coflow laminar methane/air diffusion flames: Effects of fuel dilution, inlet velocity, and gravity," *Proc. Combust. Inst.*, **35**, 897-903 (2015).

14. D. Giassi, B. Liu, and M.B. Long, "Use of High Dynamic Range Imaging for Quantitative Combustion Diagnostics," *Appl. Optics*, **54**, 4580-4588 (2015).

Conference Proceedings and Posters

1. S.B. Dworkin, B.C. Connelly, B.A.V. Bennett, A.M. Schaffer, M.B. Long, M.D. Smooke, M.P. Puccio, B. McAndrews and J.H. Miller, "Application of a Modified Vorticity-Velocity Formulation to Steady and Unsteady Laminar Diffusion Flames," *Journée des Doctorants du CMAP*, Palaiseau, France, March 7, 2007.
2. B.C. Connelly, M.D. Smooke, M.B. Long, R.J. Hall, and M.B. Colket, "Computational and Experimental Investigation of the Interaction of Soot and NOx in Coflow Diffusion Flames," *Proceedings of the 5th US Combustion Meeting*, University of California at San Diego, San Diego, CA, March 25-28, 2007.
3. B.C. Connelly, B.A.V. Bennett, S. B. Dworkin, M.D. Smooke and M. B. Long, "A Paradigm Shift in the Interaction of Experiments and Computations in Combustion Research," *Gordon Research Conference on Laser Diagnostics in Combustion*, Magdalen College, Oxford, UK, August 12-17, 2007.
4. M.B. Long, B.C. Connelly, B.A.V. Bennett and M.D. Smooke, "A Paradigm Shift in the Interaction of Experiments and Computations," *First International SAOT Workshop on Optical Diagnostics for Flow and Combustion Research*," Erlangen, Germany, August 19-21, 2007.
5. M.D. Smooke, "Computational and experimental study of soot formation in coflow diffusion flames." Invited talk at *Eastern States Section of the Combustion Institute, Technical Meeting*, Charlottesville, Virginia, October 21-24, 2007.
6. B.C. Connelly, B.A.V. Bennett, M.D. Smooke and M. B. Long, "A Paradigm Shift in the Interaction of Experiments and Computations in Combustion Research," *Eastern States Section of the Combustion Institute, Technical Meeting*, Charlottesville, Virginia, October 21-24, 2007.
7. M.B. Long, "Probing Fire with Light," guest lecture at The Summer Science Program, Socorro, NM, July 3, 2007.
8. M.B. Long, "Changing the way we think about combustion experiments – the interaction of computations and experiments," Mechanical Engineering Seminar, University of Connecticut, 17 April 2009.
9. Blair Connelly, Peter Kuhn, Bin Ma, and Marshall Long, "Current state of combustion diagnostics on the International Space Station," Gordon Research Conference on Laser Diagnostics in Combustion, Waterville Valley, NH, 16-21 August 2009.
10. Blair C. Connelly, Luca Tosatto, Mitchell D. Smooke and Marshall B. Long, "Improving the interface between experiments and computations through intelligent experimental design," Gordon Research Conference on Laser Diagnostics in Combustion, Waterville Valley, NH, 16-21 August 2009.

11. Blair C. Connelly, Marshall B. Long, Mitchell D. Smooke, Meredith B. Colket, Robert J. Hall, "Two-dimensional laser-induced incandescence for soot volume fractions and primary particle size distributions," 6th U.S. National Combustion Meeting, The University of Michigan, Ann Arbor, Michigan, 17-20 May 2009.
12. Marshall B. Long, "Imaging Flames: From Advanced Laser Diagnostics to Snapshots," Plenary Lecture at the Eastern States Section of the Combustion Institute, Fall Technical Meeting, University of Maryland, College Park, 18-21 October 2009.
13. B. Ma, S. Cao, B. A. V. Bennett, M. D. Smooke and M. B. Long, "Experimental and computational study of lifted coflow laminar diffusion flames under elevated pressures," 7th US National Technical Meeting of the Combustion Institute, Atlanta, GA, March 20-23, 2011.
14. Marshall B. Long, "Multispectral Imaging in Combustion Analysis," Invited presentation at OSA Advanced Photonics Congress, Toronto, Canada, 12-15 June 2011.
15. Jennifer D. Herdman, Blair C. Connelly, Mitchell D. Smooke, Marshall B. Long and J. Houston Miller, A comparison of Raman signatures and laser-induced incandescence with direct numerical simulation of soot growth in non-premixed ethylene/air flames," Gordon Research Conference on Laser Diagnostics in Combustion, Waterville Valley, NH, 14-19 August 2011.
16. Bin Ma and Marshall B. Long, "Can SiC Fibers Serve As An Absolute Light Calibrator?" Gordon Research Conference on Laser Diagnostics in Combustion, Waterville Valley, NH, 14-19 August 2011.
17. B. Ma and M.B. Long, "Absolute light calibration in combustion experiments," Fall Technical Meeting of the Eastern States Section of the Combustion Institute, Storrs, CT, 9-12 Oct, 2011.
18. Su Cao, Beth Anne V. Bennett, Bin Ma, Marshall B. Long, Mitchell D. Smooke, "Computational and experimental study of laminar coflow methane-air diffusion flames under elevated pressures," Fall Technical Meeting of the Eastern States Section of the Combustion Institute, Storrs, CT, 9-12 Oct, 2011.
19. B. Ma and M.B. Long, "Novel soot volume fraction measurement through ratio-pyrometry and absolute light calibration," The 5th International LII Workshop, Le Touquet, France, 9-11 May, 2012.
20. B. Ma and M.B. Long, "Absolute light calibration using S-type thermocouples," 34th International Symposium on Combustion, Warsaw, Poland, 29 July - 3 August, 2012.

Includes ISS Results from SLICE

21. B. Ma, D. Giassi, D.P. Stocker, F. Takahashi and M.B. Long, "Structure and Liftoff in Combustion Experiment (SLICE) on the ISS," Work in progress poster, 34th International Symposium on Combustion, Warsaw, Poland, 29 July - 3 August, 2012.
22. F. Takahashi, R. Kulakhmetov, D.P. Stocker, B. Ma and M.B. Long, "Microgravity Enhances the Stability of Gas-Jet Diffusion Flames", 28th Annual Meeting of the American Society of Gravitational and Space Research, Nov 28-Dec 2, 2012.
23. S. Cao, B.A.V. Bennett, B. Ma, M.B. Long and M.D. Smooke, "Effects of Pressure and Fuel Stream Dilution on the Structure of Axisymmetric Coflow Methane-Air Laminar Diffusion Flames: A Computational and Experimental Study," 14th SIAM International Conference on Numerical Combustion, San Antonio Texas, Apr 8-10, 2013.
24. B. Ma, G. Wang, G. Magnotti, R.S. Barlow, and M.B. Long, "Recent developments of thin-filament pyrometry," 8th US National Combustion Meeting, Park City UT, 19-22 May, 2013.

Includes ISS Results from SLICE

25. B. Ma, S. Cao, D. Giassi, D.P. Stocker, F. Takahashi, B.A.V. Bennett, M.D. Smooke, and M.B. Long, "An experimental and computational study on soot formation in a coflow jet flame under microgravity and normal gravity," 8th US National Combustion Meeting, Park City UT, 19-22 May, 2013.
26. B. Ma and M.B. Long, "Two-dimensional soot aggregate sizing by multi-angle light scattering," 8th US National Combustion Meeting, Park City UT, 19-22 May, 2013.

Includes ISS Results from SLICE

27. S. Cao, B.A.V. Bennett, B. Ma, D. Giassi, D.P. Stocker, F. Takahashi, M.B. Long, and M.D. Smooke, "Effects of fuel dilution and gravity on laminar coflow methane-air diffusion flames: A computational and experimental investigation," 8th US National Combustion Meeting, Park City UT, 19-22 May, 2013.
28. N. Kempema, B. Ma and M. B. Long "Full field temperature measurement in sooting coflow diffusion flames", 8th US National Combustion Meeting, Park City UT, 19-22 May, 2013.

Includes ISS Results from SLICE

29. Bolun Liu, Davide Giassi, and Marshall Long, "Use of High Dynamic Range (HDR) Imaging Algorithms for Quantitative Combustion Diagnostics," Gordon Research Conference on Laser Diagnostics in Combustion, Waterville Valley, NH, 11-16 August 2013.
30. B. Ma, S. Cao, D. Giassi, D.P. Stocker, F. Takahashi, B.A.V. Bennett, M.D. Smooke, and M.B. Long, "An experimental and computational study on soot formation in a coflow jet flame under microgravity and normal gravity," 35th International Symposium on Combustion, San Francisco, CA, 3-8 August, 2014.

31. S. Cao, B. Ma, B.A.V. Bennett, D. Giassi, D.P. Stocker, F. Takahashi, M.B. Long, and M.D. Smooke, "A computational and experimental study of coflow laminar methane/air diffusion flames: Effects of fuel dilution, inlet velocity, and gravity," 35th International Symposium on Combustion, San Francisco, CA, 3-8 August, 2014.
32. D. Giassi, B. Ma, B. Liu, S. Cao, D.P. Stocker, F. Takahashi, B.A.V. Bennett, M.D. Smooke, and M.B. Long, "Implementation of High Dynamic Range (HDR) Image Algorithms for Improved Microgravity Flame Diagnostics," Annual Meeting of the American Society for Gravitational and Space Research, Pasadena, CA, 23-26 October, 2014.
33. S. Cao, B.A.V. Bennett, B. Ma, D. Giassi, D.P. Stocker, F. Takahashi, M.B. Long, M.D. Smooke, "A numerical and experimental study of coflow laminar diffusion flames: Effects of gravity and inlet velocity," 9th U.S. National Combustion Meeting, Cincinnati, OH, 17-20 May 2015.
34. S. Cao, B.A.V. Bennett, B. Ma, M.B. Long, M.D. Smooke, "Effects of fuel dilution and pressure on coflow laminar methane-air diffusion flames: A computational and experimental investigation," 9th U.S. National Combustion Meeting, Cincinnati, OH, 17-20 May 2015.

Includes ISS Results from SLICE

35. D. Giassi, B. Liu, M.B. Long, "Use of High Dynamic Range (HDR) imaging for quantitative combustion diagnostics," 9th U.S. National Combustion Meeting, Cincinnati, OH, 17-20 May 2015.
36. D. Giassi and M.B. Long, "Signal to Noise Ratio Improvements in Rayleigh Measurements Using High Dynamic Range Imaging," Poster Presentation, 9th U.S. National Combustion Meeting, Cincinnati, OH, 17-20 May 2015.

Includes ISS Results from SLICE

37. D. Giassi and M.B. Long "Signal-to-Noise Ratio Improvements in Steady and Time Resolved Measurements Using High Dynamic Range Imaging," Gordon Research Conference on Laser Diagnostics in Combustion at Waterville Valley, NH, 9-14 August, 2015.

Ph.D. Dissertations

1. B.C. Connelly, "Quantitative Characterization of Steady and Time-Varying, Sooting, Laminar Diffusion Flames using Optical Techniques," Ph.D. Thesis, Yale University, 2009.

Includes ISS Results from SLICE

2. Bin Ma, "Development of quantitative optical techniques for microgravity combustion and sooty flame characterization," Ph.D. Thesis, Yale University, 2013.
3. Su Cao, "Development of a Mass-Conserving, Smooth Vorticity-Velocity Formulation for Chemically Reacting Flow Simulations," Ph.D. Thesis, Yale University, 2015.

Electric-Field Effects on Laminar Diffusion Flames (E-FIELD Flames) - *as of August 2015*

GRADUATE STUDENTS

Ph.D. Dissertations

A.9 Rickard, M.A. (2005) "Ion-Driven Wind: Aerodynamics, Performance Limits, and Optimization"

A.10 Papac, M.J. (2005) "Electrical Aspects of Gaseous Fuel Flames for Microgravity Combustion and Combustion Control."

A.19 Karnani, S. (2011) "Electrical Control of Combustion in Microgravity."

A.24 Chien, Y.-C. (2015) "Electrical Control of Impinging Non-Premixed Flames."

M.S. Theses

B.22 Gonzalez, M. (2000) "Prospects for an Electrohydrodynamic Spray Burner" (project)

B.24 Rickard, M.A. (2002) "The Study of an Electrified Air-Assisted Liquid Atomizer."

B.25 Papac, M.J. (2002) "N2 CARS Thermometry and O2 LIF Measurements of an Electrically Induced Microbuoyant Flame."

B.44 Tsai, H.-J. (2011) "Attempts to Model Electrical Field Effects on Flames." (project)

B.51 Kong, S. (2013) "Studying the Temperature Profile of a Flame-Heated Plate using Solidworks." (project)

B.52 Escofet-Martin, D. (2014) "OH PLIF Measurements in an Impinging Non-Premixed Flame." (project)

B.58 Tinajero, J. (2014) "Chemi-Ion Driven Flows in an Electric Field."

B.59 Ricchiuti, V. (expected 2015) "CFD of Electrically Active Flames using Open FOAM."

Visiting Researchers

C.7 Francesco Borgatelli, Polytechnic Milano – Engineering Degree student, 2006 –Feedback control of flames with electric fields, "Behavior of a Small Diffusion Flame Affected by an Electric Field," degree conferred 2008/2009.

C.11 Kiyotaka Yamashita, Post Doctoral Scientist, University of Tokyo, summer 2008 – Numerical Simulation of Electric Effects in Diffusion Flames

C.13 Julian Glorian, Universite D'Orleans, France – Engineering Degree student 2011 – Computational study of ions and excited state species in a methane/air laminar diffusion flame

C.26 Albert Aguilera Roman, Universitat Politècnica de Catalunya, Terrassa, Engineering Degree student 2014/2015 -- Relating CH* Chemiluminescence to Charged Species in a Nonpremixed Methane Flame

D.2 Benjamin Debareix, ISAE, ENSMA, France – Engineering Degree student 2011 (no formal report) – Open FOAM Computation of Jet Diffusion Flame Impinging on a Surface

D.3 Mishal Francis, University of Glasgow -- Intern student 2011/2012 -- IR detection of electrical effects on small diffusion flames

D.4 Joshua Jacobs, University of Glasgow -- Intern student 2011/2012 -- Soot imaging in small diffusion flames

D.26 Pierre Lemarie, ENSMA, 2014: Laser spectroscopy for combustion diagnostics

INVITED TECHNICAL LECTURES

- Louisiana State University Seminar – Electrical Actuation of Small Diffusion Flames, April 4, 2014
- UCLA Mechanical Engineering Departmental Seminar -- Using Old Fuels in New Ways and New Fuels in Old Ways, December 11, 2009
- UCI MAE Departmental Seminar -- Recent Research in the Lasers, Flames, and Aerosols Laboratory, October 14, 2009
- NASA Glenn Research Center, Cleveland, Ohio – Electric Field Effects in a Small Co-Flow Diffusion Flame (with S. Karnani), May 21, 2009
- Japanese Combustion Symposium, Kyoto, Japan – Electrical Manipulation of Flames, December 4, 2008
- University of Hawaii, Honolulu, HI, "Flame and Corona Ion Driven Winds," October 19, 2007
- University of California, San Diego Fluid Seminar, San Diego, CA – Convective Transport in Flame and Corona Ion-Driven Winds, January 22, 2007.

- National Cheng-Kung University, Tainan, Taiwan – Control of Ion Winds from Flames and Corona Discharges, March 23, 2006.
- Interdisciplinary Transport Phenomena in Microgravity and Space Sciences IV, Tomar, Portugal – Using Large Electric Fields to Control Transport in Microgravity, August 11, 2005
- California Institute of Technology – Characterizing Ionic Winds from Flames and Corona Discharges, February 25, 2005.
- University of Southern California, Los Angeles, California – Electric Field Manipulation of Flames: and other tales of combustion control, March 7, 2001

PUBLICATIONS

Refereed Publications

A.40 Strayer, B.A., Posner, J.D., Dunn-Rankin, D., and Weinberg, F.J. (2002) "Simulating microgravity in small diffusion flames by using electric fields to counterbalance natural convection," Proceedings of the Royal Society of London A, 458 2021, 1151-1166.

A.41 Regele, J., Papac, M., Rickard, M., and Dunn-Rankin, D. (2002) "Effects of Capillary Spacing on EHD Spraying from an Array of Cone-Jets," Journal of Aerosol Science, Volume 33, Issue 11, November 2002, Pages 1471-1479.

A.45 Papac, M.J., Dunn-Rankin, D., Stipe, C.B., and Lucas, D. (2003) "N2 CARS Thermometry and O2 LIF Concentration Measurements in an Electrically Induced Microbuoyant Flame," Combustion and Flame, 133, 241-254.

A.46 Weinberg, F.J., Carleton, F.A., and Dunn-Rankin, D. (2003) "Electrically Charged Dispersions of Extinguishants for use in Microgravity Environments," Combustion Science and Technology, 175, 2161-2179.

A.48 Rickard, M., Dunn-Rankin, D., Weinberg, F., and Carleton, F. (2005) "Characterization of Ionic Wind Velocity," Journal of Electrostatics, 63, 711-716.

A.49 Weinberg, F., Carleton, F.A., and Dunn-Rankin, D. (2003) "Electrically Charged Dispersions of Extinguishants for use in Microgravity Environments," Combustion Science and Technology, 175, 2161-2179.

A.51 Rickard, M.A., Dunn-Rankin, D., Weinberg, F.J., and Carleton, F. (2006) "Maximizing Ion Driven Gas Flows," Journal of Electrostatics, 64, 368-276.

A.54 Papac, M.J. and Dunn-Rankin, D. (2008) "Modeling Electric Field Driven Convection in Small Combustion Plasmas and Surrounding Gases," Combustion Theory and Modeling, 12, 23-44.

A.55 Rickard, M.A. and Dunn-Rankin, D. (2007) "Numerical Simulation of a Tubular Ion-Driven Wind Generator," Journal of Electrostatics, 65, 646-654.

A.56 Weinberg, F.J., Carleton, F., and Dunn-Rankin, D. (2008) "Electric Field Controlled Mesoscale Burners," Combustion and Flame, 152, 186-193.

ICA.1 Weinberg, F.J., Carleton, F., (2009) "Ionization and chemiluminescence during the progressive aeration of methane flames," Combustion and Flame, 156, 2276-2284.

A.64 Yamashita, K., Karnani, S., and Dunn-Rankin, D. (2009) "Numerical prediction of ion current from a small methane jet flame," Combustion and Flame, 156, 6, 1227-1233.

A.68 Weinberg, F.J., Carleton, F., Houdmont, R., Dunn-Rankin, D., and Karnani, S. (2011) "Syngas Formation in Methane Flames and Carbon Monoxide Release during Quenching," Combustion and Flame, 158, 273-280.

A.73 Borgatelli, F. and Dunn-Rankin, D. (2011) "Behavior of a Small Diffusion Flame as an Electrically Active Component in a High-Voltage Circuit," Combustion and Flame, 159, 210–220.

A.76 S. Karnani, D. Dunn-Rankin, F. Takahashi, Z-G. Yuan, D. Stocker (2012) "Simulating Gravity in Microgravity Combustion using Electric Fields," Combustion Science and Technology, 184, 1891--1902.

A.80 Karnani, S. and Dunn-Rankin, D. (2013) "Visualizing CH* Chemiluminescence in Sooting Flames," Combustion and Flame, 160, 10, 2275--2278.

A.83 Karnani, S. and Dunn-Rankin, D. (2015) "Detailed Characterization of DC Electric Field Effects on Small Non-Premixed Flames," Combustion and Flame, 162, 2865--2872.

<u>Refereed Conference Proceedings</u> (full peer-review)

B.8 Carleton, F., Dunn-Rankin, D., and Weinberg, F.J. (1998) "Optics of Small Diffusion Flames in Micro-gravity," Proceedings of the 27th International Symposium on Combustion, 2567-2572.

B.11 Rickard, M. and Dunn-Rankin, D. (2002) "Experimental study of an electrohydrodynamic, air-assisted liquid atomizer," SAE Transactions: Journal of Fuels and Lubricants, 1523-1531

B.14 Dunn-Rankin, D. and Weinberg, F.J. (2006) "Using Large Electric Fields to Control Transport in Microgravity," Annals of the New York Academy of Sciences, 1077, 570-584.

B.15 Papac, M.J. and Dunn-Rankin, D. (2006) "Canceling Buoyancy of Gaseous Fuel Flames in a Gravitational Environment using an Ion Driven Wind," Annals of the New York Academy of Sciences, 1077, 585-601.

B.19 F.J. Weinberg, F.J., Dunn-Rankin, D., Carleton, F.B., Karnani, S., Markides, C., and Zhai, M. (2013) "Electrical aspects of flame quenching," Proceedings of the Combustion Institute, 34, 3295-3301.

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D.43 Strayer, B.A., Posner, J.D., and Dunn-Rankin, D. (2000) "CARS Temperature Measurements of a Non-premixed Flame under Electric Field Control," Western States Section/The Combustion Institute Spring Meeting, Colorado School of Mines, Golden, CO, March 13-14.

D.47 Dunn-Rankin, D., Papac, M., Regele, J., and Rickard, M. (2001) "EHD Spraying from Single and Multiple Capillaries," 14th Annual International Liquid Atomization and Spray Systems (ILASS)-Americas Conference, Dearborn, Michigan, May 21-23. (see A.41)

D.49 Dunn-Rankin, D., Strayer, B.A., Carleton, F.A., and Weinberg, F.J. (2001) "Electrical Aspects of Microgravity Combustion," 6th Microgravity Combustion Workshop, Cleveland, Ohio, May 22-24.

D. 50 Strayer, B.A. and Dunn-Rankin, D. (2001) "Control of the Vaporization Rate in a Droplet Stream Flame using Electric Fields," Proceedings of NHTC'01, the 35th ASME National Heat Transfer Conference, Anaheim, California, June 10-12.

D.51 Strayer, B.A. and Dunn-Rankin, D. (2001) "Response of a Non-Premixed Flame to Electric Field Forcing," 18th International Colloquium on the Dynamics of Explosions and Reactive Systems, Seattle, Washington, July 29-August 3.

D.53 Weinberg, F.J., Carleton, F.A., and Dunn-Rankin, D. (2002) "Electrically Charged Dispersions of Extinguishants for use in Microgravity Environments," Mediterranean Combustion Symposium, Sharm El-Sheikh, Egypt, January 6-11. (see A.46)

D.55 Papac, M.J., Dunn-Rankin, D., Stipe, C.B., and Lucas, D. (2002) "CARS Temperature and LIF Oxygen Concentration Measurements in an Electrically Induced Microbuoyant Flame," Paper-072 of the Western States Section/The Combustion Institute Spring Meeting, San Diego, CA, March 25–26. (see A.45)

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D.59 Rickard, M. and Dunn-Rankin, D. (2002) "Experimental study of a hybrid electrohydrodynamic, air-assisted liquid atomizer," SAE Paper FFL02-15, Fuels and Lubricants Conference, San Diego, CA, October 21–24. (see B.11)

D.62 Dunn-Rankin, D. and Weinberg, F.J. (2003) "Flames and Electric Fields in Microgravity," 7th International Workshop on Microgravity Combustion, Cleveland, Ohio, June 2–5.

D.63 Rickard et al. (2003) "Ionic Wind as a Controllable Air Source for an Electric Burner,"

Western States Section/The Combustion Institute Fall Meeting, UCLA, October 20–21.

D.69 Rickard, M.A., Carleton, F., Dunn-Rankin, D., and Weinberg, F.J. (2005) "Characterization of Ionic Wind Velocity," Paper PFA-19, Proceedings of Electrostatics2005, Helsinki, Finland, June.

D.73 Gowadia, N. and Dunn-Rankin, D. (2005) "Electrospraying Biologically Active Materials," ILASS Americas 18th Annual Conference on Liquid Atomization and Spray Systems, Irvine, CA, May 23–25.

D.76 Dunn-Rankin, D. and Weinberg, F.J. (2005) "Using Large Electric Fields to Control Transport in Microgravity," Proceedings of the Physics of Transport in Microgravity Science Conference, Tomar, Portugal, August 8–12.

D.77 Papac, M.J. and Dunn-Rankin, D. (2005) "Canceling Buoyancy of Gaseous Fuel Flames in a Gravitational Environment using an Ion Wind," Proceedings of the Physics of Transport in Microgravity Science Conference, Tomar, Portugal, August 8–12.

D.80 Papac, M.J., Chueh, P., Dunn-Rankin, D., and Weinberg, F.J. (2005) "Voltage Current Characteristics of Small Diffusion Flames under the Combined Influence of Ion-Driven Winds and Natural Convection," Paper 05-F30, Proceedings of the Western States Section/The Combustion Institute Fall Meeting, Stanford, CA, October 17–18.

D.83 Borgatelli, F. and Dunn-Rankin, D. (2006) "Feedback Control of Ion Current from a Small Diffusion Flame," Paper 06S-44, Western States Section/The Combustion Institute Spring Meeting, University of Idaho, Boise, March 27–28.

D.91 Bennett, M., Borgatelli, F. and Dunn-Rankin, D. (2007) "Behavior of Non Premixed Flames as Electrically Active Components in a High-Voltage Circuit," 21st International Colloquium on Dynamics of Explosions and Reactive Systems, Poitiers, France, July 23–27.

D.101 Karnani, S., Bennett, M., and Dunn-Rankin, D. (2008) "Electrical Properties of Small Diffusion Flames," Western States Section/The Combustion Institute Spring Meeting paper 08S-4, University of Southern California, Los Angeles, March 17–18.

D.106 Dunn-Rankin, D. (2008) "Electrical Manipulation of Flames," invited lecture, Japanese Combustion Symposium, Kyoto, Japan, December 4.

D.107 Karnani, S. and Dunn-Rankin, D. (2009) "Electric Field Effects on a Small Co-Flow Diffusion Flame," Paper 13A1, U.S. Combustion Meeting, Ann Arbor, Michigan, May 18–20.

D.115 Karnani, S., Coffin, P., Schoen, M., Dunn-Rankin, D., Takahashi, F., Yuan, Z.-Y., and Stocker, D. (2009) "Exploring the effects of gravity on a coflow diffusion flame in an electric field," Paper 09F-79 at the Western States Section/The Combustion Institute Fall Meeting, University of California, Irvine, October 26–27.

D.126 Swenson, K., Karnani, S., Dunn-Rankin, D., Takahashi, F., Stocker, D., and Guang, Z.-G. (2011) "Electric Field Induced Convection in Microgravity Combustion," 7th US National Combustion Meeting, Georgia Institute of Technology, Atlanta, GA, March 20–

23.

D.129 Karnani, S., Dunn-Rankin, D., Takahashi, F., Yuan, Z.G., and Stocker, D. (2011) "Simulated Gravity Using Electric Fields in Microgravity Combustion," 23rd International Colloquium on the Dynamics of Explosions and Reactive Systems, Irvine, CA, July 24–29.

D.139 Chien, Y.-C. and Dunn-Rankin, D. (2013) "Electric Field Effects on Carbon Monoxide Release from Impinging Flames," Paper 070MI-0360, US Combustion Meeting, Park City, Utah, May 20--23.

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D.142 Karnani, S. and Dunn-Rankin, D. (2013) "Visualizing CH* Chemiluminescence in Sooting Flames via Image Post-Processing," Paper 070DI-0393, US Combustion Meeting, Park City, Utah, May 20--23.

D.144 Chien, Y.-C., Yamashita, K., and Dunn-Rankin, D. (2013) "Electrical Aspects of Impinging Flames," 24th International Colloquium on the Dynamics of Explosions and Reactive Systems, Paper 126, Taipei, Taiwan, July 28--August 2.

D.150 Takahashi, F., Nagapetyan, H., Stocker, D.P., and Dunn-Rankin, D. (2014) "Transient Responses of Jet Diffusion Flames to a DC Electric Field in Microgravity," Spring Technical Meeting of the Central States Section/The Combustion Institute, Tulsa, OK, March 16—18.

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D.153 Chien, Y.C. and Dunn-Rankin, D. (2014) "Temperature measurement over a quenching plate with electric field flames," Western States Section/The Combustion Institute Spring Meeting paper 087LF-0060, California Institute of Technology, Pasadena, CA, March 24--25.

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D.157 Aguilar, A., Tinajero, J., and Dunn-Rankin, D. (2015) "Relating CH*

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D.161 Escofet-Martin, D., Chien, Y.-C., and Dunn-Rankin, D. (2015) "Two-Line OH PLIF Temperature Measurements of Flames Near a Quenching Plate," 25th International Colloquium on the Dynamics of Explosions and Reactive Systems, Leeds University, England, August 2--7.

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E.47 Strayer, B.A., Posner, J.D., Dunn-Rankin, D., and Weinberg, F.J. (2000) "Further Studies on Simulating Microgravity Flames using Electric Fields," Poster Session, 28th International Symposium on Combustion, Edinburgh, July 30–August 4.

E.50 Papac, M.J. and Dunn-Rankin, D. (2004) "Ion current measurements and Schlieren imagery of acetylene, ethylene, ethane and methane diffusion flames exposed to electric fields", Poster Session – 30th International Symposium on Combustion, University of Illinois, Chicago, August.

E.55 Weinberg, F.J., Carleton, F.A., and Dunn-Rankin, D. (2006) "Electric Field Controlled Mesoscale Burners," Poster 1A14, 31st International Combustion Symposium, Heidelberg, Germany, August 7-13.

E.62 Karnani, S.S., Bennett, M., Yamashita, K., and Dunn-Rankin, D. (2008) "W5P019: Recent progress in exploring electric field effects on diffusion flame," Poster Session of the 32nd International Combustion Symposium, Montreal, Canada, August 3–9.

E.71 Proctor, C., Karnani, S., Dunn-Rankin, D., Takahashi, F., Yuan, Z.-G., and Stocker, D. (2010) "Exploring Electric Field Effects on Laminar Diffusion Flames in Microgravity," Poster Session of the 33rd International Combustion Symposium, Beijing, China, August 2-6.

E75 Chien, Y.C., Jaquez-Nunez, M., Francis, M., Jacobs, J., Karnani, S., and Dunn-Rankin, D. (2012) "Recent Progress in Studying Emissions from Electric Field Effects on Flames," W5P040- Work-in-Progress Poster, International Combustion Symposium, Warsaw, Poland, July 30-August 3.

E.80 Tinajero, J.A., Karnani, S.V., and Dunn-Rankin, D. "E-Field: Electric Field Effects on Laminar Diffusion Flames," 29th American Society for Space Research Annual Meeting and 5th International Symposium for Physical Sciences in Space, Orlando, Florida, November 3-8, 2013.

E.82 Chien, Y.C., Escofet-Martin, D., and Dunn-Rankin, D. (2014) "Electric Field Effects on CO Emission from Non-Premixed Quenching Flames," Work-in-Progress poster session, 35th International Combustion Symposium, San Francisco, CA, August 2-7.

E.88 Tinajero, J. and Dunn-Rankin, D. (2014) "Carbon Particle Behavior in Flames Exposed to an Electric Field," Work-in-Progress poster session, 35th International Combustion Symposium, San Francisco, CA, August 2-7.

E.89 Tinajero, J., Dunn-Rankin, D., Bai, J., and Plascencia, M. (2014) "Ground-Based Schlieren Experiments of Chemi-Ion Driven Flows in a Time Varying Electric Field" American Society for Gravitational and Space Research (ASGSR) Annual Meeting, Pasadena, CA, October 22-26.

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G.3 " High-Velocity, Multistage, Nozzled, Ion Driven Wind Generator and Method of Operation of the Same Adaptable to Mesoscale Realization," Derek Dunn-Rankin and Matthew J. Rickard. United States Patent US 7,911,146 B2, issued March 22, 2011.

Flame Design *- as of August 2015*

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19. V.R. Lecoustre, P.B. Sunderland, B.H. Chao, R.L. Axelbaum, *Modeled Quenching Limits of Spherical Hydrogen Diffusion Flames*, Proceedings of the Combustion Institute 34 (2013) 887-894.

18. F. Xia, R.L. Axelbaum, *Simplifying the Complexity of Diffusion Flames Through Interpretation in C/O Ratio Space*, Computers and Mathematics with Applications, 65 (2013) 1625-1632.

17. F. Xia, G.S. Yablonsky, R.L. Axelbaum, *Numerical Study of Flame Structure and Soot Inception Interpreted in Carbon-to-Oxygen Atom Ratio Space*, Proceedings of the Combustion Institute, 34 (2013) 1085-1091.

16. F. Yi, R.L. Axelbaum, *Stability of Spray Combustion for Water/Alcohols Mixtures in Oxygen-Enriched Air*, Proceedings of the Combustion Institute, 34 (2013) 1697-1704.

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14. Q. Wang, B.H. Chao, *Kinetic and Radiative Extinctions of Spherical Burner-Stabilized Diffusion Flames*, Combustion and Flame 158 (2011) 1532-1541.

13. V.R. Lecoustre, P.B. Sunderland, B.H. Chao, R.L. Axelbaum, *Extremely Weak Hydrogen Flames*, Combustion and Flame 157 (2010) 2209-2210.

12. S.A. Skeen, G. Yablonsky, R.L. Axelbaum *Characteristics of Non-Premixed Oxygen-Enhanced Combustion: II. Flame Structure Effects on Soot Precursor Kinetics Resulting in Soot-Free Flames*, Combustion and Flame 157 (2010) 1745-1752.

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9. Santa, K.J., Chao, B.H., Sunderland, P.B., Urban, D.L., Stocker, D.P., Axelbaum, R.L., *Radiative Extinction of Gaseous Spherical Diffusion Flames in Microgravity*, Combustion and Flame 151 (2007) 665-675.

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5. Liu, S., Chao, B.H. and Axelbaum, R.L., *A Theoretical Study on Soot Inception in Spherical Burner-Stabilized Diffusion Flames*, Combustion and Flame 140 1-23 (2005).

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10. Melvin Rodenhurst, *Kinetic Extinction Limit of a Spherical Diffusion Flame Attached to a Burner Surface*, M.S. thesis, Department of Mechanical Engineering, University of Hawaii (2012).

9. Vivien R. Lecoustre, *Numerical Investigations of Gaseous Spherical Diffusion Flames*, Ph.D. Dissertation, University of Maryland, Department of Mechanical Engineering, December (2009).

8. Scott A. Skeen, *Oxygen-Enhanced Combustion: Theory and Applications*, Ph.D. Dissertation, Department of Energy, Environmental and Chemical Engineering, Washington University, August (2009).

7. Ben Kumfer, Ph.D. Dissertation, Department of Energy, Environmental and Chemical Engineering, Washington University (2009).

6. Chad Unrau, Ph.D. Dissertation, Department of Energy, Environmental and Chemical Engineering, Washington University (2009).

5. Wang, Q., *Kinetic and Radiative Extinctions of Spherical Diffusion Flames*, M.Sc. Thesis, University of Hawaii (2007).

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of Temperature Effects on Soot Precursors in Ethylene Premixed Flames, 9th U.S. National Combustion Meeting, Cincinnati, 10 pp. (2015).

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35. V.R. Lecoustre, P.B. Sunderland, B.H. Chao, R.L. Axelbaum, *Numerical Investigation of Hydrogen Diffusion Flame Quenching Limits in Microgravity*, Central States Section of the Combustion Institute, Dayton (2012) 9 pp.

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33. V.R. Lecoustre, P.B. Sunderland, B.H. Chao, R.L. Axelbaum, *Characterization of Microgravity Spherical Diffusion Flame Sooting Limits*, 7th U.S. National Combustion Meeting, Atlanta (2011) 6 pp.

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29. V.R. Lecoustre, P.B. Sunderland, B.H. Chao, D.L. Urban, D.P. Stocker, R.L. Axelbaum, *Numerical Simulations of Spherical Diffusion Flames at their Sooting Limits*, 6th U.S. National Combustion Meeting, Ann Arbor (2009) 9 pp.

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25. Q. Wang, and B.H. Chao, , Kinetic and Radiative Extinction of Spherical Diffusion Flames, 5th U.S. Combustion Meeting, San Diego (2007) 12 pp.

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15. K.J. Santa, Z. Sun, R.L. Axelbaum, B.-H. Chao, P.B. Sunderland, D.L. Urban, D.P. Stocker, Numerical and Experimental Observations of Spherical Diffusion Flames, 4th

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