CURRICULUM VITAE

IAIN D. BOYD

H.T. Sears Memorial Professor of Aerospace Engineering Sciences
Director, Center for National Security Initiatives
Director, NASA Space Technology Research Institute - ACCESS
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EDUCATION

12/88	Ph. D. in Aeronautics and Astronautics, University of Southampton, England
7/85	B. Sc. (with honors) in Mathematics, University of Southampton, England

EMPLOYMENT HISTORY

08/19 – present	Director, Center for National Security Initiatives Research & Innovation Office, University of Colorado, Boulder, CO
08/19 – present	H.T. Sears Memorial Professor of Aerospace Engineering Sciences University of Colorado, Boulder, CO
10/10 – 08/19	James E. Knott Professor of Aerospace Engineering, University of Michigan, Ann Arbor, Michigan
07/17 – 06/19	Faculty Director of Government Relations University of Michigan, Washington, DC
8/02 – 9/10	Professor of Aerospace Engineering, University of Michigan, Ann Arbor, Michigan
6/99 - 8/02	Associate Professor of Aerospace Engineering, University of Michigan, Ann Arbor, Michigan
11/95 - 5/99	Associate Professor Mechanical and Aerospace Engineering, Cornell University, Ithaca, New York

1/93 - 10/95	Assistant Professor Mechanical and Aerospace Engineering, Cornell University, Ithaca, New York
1/89 - 12/92	Research Scientist Eloret Institute, NASA Ames Research Center, Moffett Field, California

HONORS AND AWARDS

01/2025	AIAA International Space Planes and Hypersonic Systems and Technologies Conference Best Paper Award
06/2023	AIAA Thermophysics Best Student Paper Award
06/2021	AIAA Thermophysics Best Student Paper Award
06/2019	AIAA Thermophysics Best Paper Award
06/2018	AIAA Thermophysics Award
10/2017	Fellow, Royal Aeronautical Society
07/2017	Chief of Staff of the Air Force Award for Exceptional Public Service
10/2014	Fellow, American Physical Society
06/2012	AIAA Thermophysics Best Student Paper Award
06/2011	AIAA Thermophysics Best Paper Award
05/2011	Fellow, American Institute of Aeronautics & Astronautics
10/2009	James E. Knott Professor of Engineering
06/2009	Paper selected by *Physics of Plasmas* as one of its most significant publications in 50 years
03/2009	UM Monroe-Brown Foundation Research Excellence Award
09/2006	CTR Senior Fellow (Stanford University)
06/2005	AIAA Thermophysics Best Student Paper Award
03/2004	UM Aerospace Outstanding Achievement Award
01/1998	AIAA Lawrence Sperry Award
09/1997	Cornell Engineering College Teaching Award
07/1997	AIAA Electric Propulsion Best Paper Award

ACADEMIC EXPERIENCE

A. Courses Taught

Hypersonic Aerothermodynamics	(graduate; 2003, 2004, 2007; Michigan)
Molecular Gas Dynamics	(graduate; 2003-2006, 2008-2016; Michigan)
Gas Kinetic Theory	(graduate; 2000, 2001; Michigan)
Introduction to Gas Dynamics	(undergraduate; 2000-2002,2005; 2009-2015; Michigan)
Spacecraft Engineering	(undergraduate; 1997, 1998; Cornell)

Compressible Fluid Flow	(graduate; 1996, 1997, 1998; Cornell)
Physics of Fluids	(graduate; 1994-1996, 1999; Cornell)
Introduction to Aeronautics	(undergraduate; 1993-1995; Cornell)
Computational Aerodynamics	(graduate; 1993; Cornell)

B. Graduate Students/Visitors

Current Students:

Sarah Kinney (Co-Advised with John Evans)
Alec Yenawine
Cate Leszcz
Sindhu Manchikanti
Nick Carter
Matthew Stasiukivicius
Michael Sands
Marisa Petrusky
Kalvin Monroe
Mitchell Wall
Jennifer Horing (Co-advised with Kurt Maute)
Tyler Nichols
Jens Rataczak (Co-Advised with Jay McMahon)
Charles Lipscomb
Amin Taziny

Graduated Students:

56. Tim Aiken *University of Colorado*	(PhD, Colorado)
55. Tommy Kava *Lockheed Martin*	(PhD, Colorado)
54. Pawel Sawicki *Blue Origin*	(PhD, Colorado, 2022)
53. Kaelan Hansson *NASA Ames Research Center*	(PhD, Michigan, 2021)
52. Michael Holloway *Applied Physics Laboratory*	(PhD, Michigan, 2021)
51. Alexander Vazsonyi *Naval Research Laboratory*	(PhD, Michigan, 2021)
50. Candice Kaplan *KLA*	(PhD, Michigan, 2021)
49. David Dang	(PhD, Michigan, 2021)

Facebook

48. Sam Chen (PhD, Michigan, 2020)
Applied Physics Laboratory

47. Astrid Raisanen (PhD, Michigan, 2020)
Applied Physics Laboratory

46. Lauren Mackey (PhD, Michigan, 2019)
General Electric

45. Horatiu Dragnea (PhD, Michigan, 2018)
Aerospace Corporation

44. Peter Cross (PhD, Michigan, 2017)
Naval Air Weapons Center

43. Kyle Hanquist (PhD, Michigan, 2017)
University of Arizona

42. Kevin Neitzel (PhD, Michigan, 2017)
Sierra Nevada Corporation

41. Maria Choi (PhD, Michigan, 2016)
NASA Glenn Research Center

40. Brandon Smith (PhD, Michigan, 2015)
Spectral Sciences, Inc.

39. Kentaro Hara (PhD, Michigan, 2015)
Stanford University

38. Ashley Verhoff (PhD, Michigan, 2015)
Air Force Research Laboratory

37. Jon Wiebenga (PhD, Michigan, 2014)
Williams International

36. Cyril Galitzine (PhD, Michigan, 2014)
Northeastern University

35. Anna Abhilasha (PhD, Michigan, 2013)
Dassault Systemes

34. Andrew Crow (PhD, Michigan, 2013)
Lockheed-Martin

33. Adam Irvine (PhD, Michigan, 2013)
Onyx Aerospace

32. Paul Giuliano (PhD, Michigan, 2013)
Planet

31. Eunji Jun (PhD, Michigan, 2012)
KAIST, South Korea

30. Hicham Alkandry (PhD, Michigan, 2012)
Applied Physics Laboratory

29. Tyler Huismann (PhD, Michigan, 2011)
University of Oklahoma

28. Tim Deschenes (PhD, Michigan, 2011)
Spectral Sciences, Inc.

27. Erin Farbar (PhD, Michigan, 2010)
General Motors, Canada

26. Tim Holman (PhD, Michigan, 2010)
Naval Research Laboratory

25. Nick Bisek (PhD, Michigan, 2010)
Air Force Research Laboratory

24. Minkwan Kim (PhD, Michigan, 2009)
University of Southampton, United Kingdom

23. Andrew Porwitzky (PhD, Michigan, 2008)
Sandia National Laboratory

22. Jeremy Boerner (PhD, Michigan, 2008)
Sandia National Laboratory

21. Yongjun Choi (PhD, Michigan, 2008)
Michigan State University

20. John Yim (PhD, Michigan, 2008)
NASA Glenn Research Center

19. Jose Padilla (PhD, Michigan, 2007)
NASA Langley Research Center

18. Andrew Lofthouse (PhD, Michigan, 2007)
United States Air Force Academy

17. Leonardo Scalabrin (PhD, Michigan, 2007)
Embraer, Brazil

16. Tom Schwartzentruber (PhD, Michigan, 2007)
University of Minnesota

15. Matt McNenly (PhD, Michigan, 2006)
Lawrence Livermore National Laboratory

14. Michael Martin (PhD, Michigan, 2006)
National Renewable Energy Laboratory

13. Jon Burt (PhD, Michigan, 2006)
NASA Glenn Research Center

12. Anton VanderWyst (PhD, Michigan, 2006)
Northrop-Grumman Corporation

11. Chunpei Cai (PhD, Michigan, 2005)
Michigan Technical University

10. Jerry Emhoff (PhD, Michigan, 2005)
Applied Physics Laboratory

9. Justin Koo (PhD, Michigan, 2005)
Air Force Research Laboratory

8. Wen-Lan Wang (PhD, Michigan, 2004)
Foxconn Technology Group

7. Quanhua Sun (PhD, Michigan, 2003)
Chinese Academy of Sciences

6. Jitendra Balakrishnan (PhD, Cornell, 2001)
Corning

5. Jyothish George (PhD, Cornell, 2000)

4. Douglas VanGilder (PhD, Cornell, 2000)
CRAFT Technology

3. Daniel Karipides (PhD, Cornell, 1999)
Tech-X Corporation

2. Gang Chen (PhD, Cornell, 1998)
Brion Technologies

1. Keith Kannenberg (PhD, Cornell, 1998)
Lockheed-Martin

Research Staff:

Sara Swenson (Postdoc: 2024 – present)
Tim Aiken (Postdoc: 2024 – present)
Nathan Miller (Research Associate: 2023 – present)
Chris Roseman (Postdoc: 2023 – present)
Nick Campbell (Research Associate: 2020 – present)
Daniil Andrienko (Research Associate: 2021 – present)
Ross Chaudhry (Research Associate: 2018 – present)
Kaelan Hansson (Postdoc: 2021 – 2023)
Ron Chan (Postdoc: 2021 – 2023)
Savio Poovathingal (Postdoc: 2018 – 2019)
Kyle Hanquist (Postdoc: 2017 – 2019)
Sinan Eyi (Visitor from Turkey: 2017-2018)
Brandon Smith (Research Scientist: 2015 – 2018)
Daniil Andrienko (Postdoc: 2014 – 2017)
Andrew Weaver (Postdoc: 2015 – 2017)
Michael Logue (Postdoc: 2015 – 2016)
Anna Abhilasha (Postdoc: 2013 – 2015)
Kelly Stephani (Postdoc: 2012-2014)
Hicham Alkandry (Postdoc: 2012-2014)
Erin Farbar (Research Scientist: 2010-2016)
Jaegang Kim (Postdoc: 2010-2014)
Tom Scanlon (Visitor from Strathclyde Univ.: 2012)
Alexandre Martin (Postdoc: 2007-2010)
Minkwan Kim (Postdoc: 2009-2010)
Jon Burt (Postdoc: 2006-2010)
Michael Keidar (Research Scientist: 1998-2005)
Quanhua Sun (Postdoc: 2003-2005)
Andrew Christlieb (Postdoc: 2001-2002)
Jing Fan (Postdoc: 1998-2000)
Laurent Garrigues (Postdoc: 2000)
Sergey Gimelshein (Postdoc: 1998)
Savino Longo (from University of Bari: 1997-1998)
Stefan Stefanov (Visitor from Sofia, Bulgaria: 1997)
Koffi Kossi (Postdoc: 1996-1998)
Gabriel Font (Postdoc: 1995-1997)
Stefan Dietrich (Postdoc: 1993-1995)

C. University of Service

University of Colorado
Director, Center for National Security Initiatives
Member, National Security Advisory Board, University of Colorado System
Director, Hypersonic Vehicles Interdisciplinary Research Team (2020-2022)
Member, Executive Committee, Department of Aerospace Engineering (2020-2023)
Member, Department Faculty Performance Evaluation Committee (2023-present)

University of Michigan
Faculty Director of Government Relations, Washington, DC (2017-2019)
Member, Executive Committee, Michigan Institute for Plasma Science & Engineering (2012-2017)
Member, Aerospace Engineering Internal Review Committee (2013)
Member, Executive Committee, Michigan Institute for Computational & Discovery Engineering (2013-2014)
Chair, Aerospace Department Head Search Committee (2010-2011)
Chair, College of Engineering Honors & Awards Committee (2010)
Member, College of Engineering Research Computing Committee (2010-2011)
Member, College of Engineering Honors & Awards Committee (2009)
Member, Aerospace Engineering Graduate Committee (2008-present)
Member, Aerospace Engineering Undergraduate Committee (2000-2002)
Member, Aerospace Engineering Faculty Search Committee (2008-2009)
College of Engineering freshmen advisor (2007-2008)
Faculty Advisor, Michigan Rocket Engineering Association (2007-2012)
Chair, Aerospace Engineering Faculty Search Committee (2005-2006)
Member, Aerospace Department Head Search Committee (2004-2005)
Faculty Advisor, Student Chapter of AIAA (2002-2005)
Undergraduate Program Advisor in Aerospace Engineering (2000-2003)
Chair, Aerospace Engineering Curriculum Committee (2003-2005)
Member, College of Engineering Faculty Phase of the Anniversary Campaign (2002-2005)
Member, College of Engineering Nominating Committee (2002-2003)
Member, University of Michigan Senate Assembly (2002-2005)
Director, W.M. Keck Computational Fluid Dynamics Laboratory (2002-2011)

D. Software Licensing

MONACO:
- BAE (2024-present)
- Raytheon (2024-present)
- Leidos (2023-present)
- The Aerospace Corporation (2020-present)
- Naval Research Laboratory (2017-present)
- NASA Glenn Research Center (2017)
- Blue Origin (2016)

- Space Exploration Company (2016)
- Boeing Space & Intelligence Systems (2013)
- ESI Group (2011)

LeMANS-MOPAR:
- In-Orbit Aerospace (2023-present)
- CFD Research Corporation (2022-present)
- Applied Physics Laboratory (2022-present)
- Naval Research Laboratory (2017-present)
- L3-Harris Corporation (2019-2022)
- Raytheon Missile Systems (2016)
- Southwest Research Institute (2016)
- Active Cooling Technologies, Inc. (2015)
- Virtual EM Inc., Ann Arbor, MI (2013)
- Corvid Technologies (2013)

EXTERNAL PROFESSIONAL ACTIVITIES

A. Journal Editorships and Reviewing

Editorial Board, *Physical Review Fluids*, (2016-2022)
Associate Editor, *Journal of Thermophysics and Heat Transfer,* (2016-2020)
Editorial Board, *Physics of Fluids*, (2014-2015)
Associate Editor, *Journal of Spacecraft and Rockets,* (1994-2015)
Editorial Board, *International Journal of Aerospace Engineering*, (2010-2013)
Editorial Advisory Board, *The Open Aerospace Engineering Journal*, (2009-2011)
Manuscript reviewer for more than 50 different journals spanning engineering, physics, chemistry, and scientific computation.
Proposal reviewer for *NASA, NSF, AFOSR, ARO.*

B. Board, Committee, and Panel Activities

Member, Science, Technology, & Engineering Committee, Boards of Managers, Sandia National Laboratory, (2021 – present)
Member, IDA DSSG Alumni Outreach Group, (2018 – present)
Member, IDA Hypersonics Working Group, (2018 – present)
Member, Board on Army RDT&E, Systems Acquisition, and Logistics (2019 – 2022)
Member, AIAA Public Policy Committee, (2019 – 2022)
Member, Predictive Engineering & Science Panel, Advanced Simulation & Computation Program, Sandia National Laboratories (2022)
Member, Strategic Advisory Group on Counter Hypersonics, Northrop-Grumman Corporation (2019 – 2020)
Member, AIAA Fellows Selection Committee (2017 – 2019)
Member, National Academies Intelligence Science & Technology Expert

Group (2016 – present)
Panelist, Hypersonics, Aerospace States Association Annual Meeting, New Orleans, LA (2024)
Panelist, Very Low Earth Orbit, SEASONS Conference, Laurel, MD (2023)
Panelist, Future Needs, Hypersonics Defense Conference, Huntsville, AL (2023)
Panelist, Very Low Earth Orbit Air Breathing Propulsion, AIAA ASCEND, Las Vegas, NV (2023)
Panelist, Unidentified Aerial Phenomena, ScienceWriters2023, Boulder, CO (2023)
Panelist, Next Generation Materials for Extreme Environments, AIAA SCITECH Conference, National Harbor, MD (2023)
Panelist, Generating a U.S. Hypersonics Pipeline, DOD Hypersonic Capabilities Symposium, National Harbor, MD (2021)
Panelist, University Hypersonic Research Partnerships, Hypersonic Capabilities Conference, Purdue, IN (2019)
Panelist, Materials for Hypersonics, Defense Strategies Institute, Alexandria, VA (2019)
Member, National Academies Panel for Assessment of the Army Research Laboratory (2019)
Member, National Academies Panel for Assessment of Independent Research at the Army's Research and Development Centers (2018)
Member, IDA Forum on Emerging Areas of Science & Technology Policy (2018)
Panelist, Hypersonics 101, AIAA, U.S. Capitol Building, Washington, DC (2018)
Member and Vice Chair, Air Force Scientific Advisory Board (2010-2017)
Member, Review Board for DOE Exascale Computing Requirements (2016)
Member, Board of Directors, Space United (2013 – 2014)
Member, Panel on USAF R&D, AFA Symposium, Langley AFB (2015)
Member, Review Board for AFRL High Speed Strike Weapons Program (2015)
Member, Scientific Committee, 5th International Workshop, Radiation of High Temperature Gases in Atmospheric Entry, Barcelona, Spain (2012)
Member, NATO RTO-AVT, Catalytic Gas-Surface Interactions (2011-2012)
Member, NSF Proposal Review Panel on Combustion & Plasmas (2010)
Member, Scientific Committee, 4th International Workshop, Radiation of High Temperature Gases in Atmospheric Entry, Paris, France (2010)
Member, Defense Science Study Group (2008-2009)
Member, Board of Honor of Rarefied Gas Dynamics (2008 – present)
Member, National Academies Panel for Panel for Assessment of NASA Aeronautics Program (2007-08)
Member, Review Board on Aerothermodynamics for NASA Mars Science Laboratory (2007)
Co-Lead for Aerothermodynamics, Hypersonics Education Initiative (2007)
Member, AIAA Electric Propulsion & Power Technical Committee (1997-2007)
Member, NSF Proposal Review Panel on Plasma Science (2006)
Member, Organizing Committee of 2002 Rarefied Gas Dynamics Symposium
Member, Organizing Committee of 2001 AIAA Joint Propulsion Conference

C. Membership of Professional Societies

Fellow, American Institute of Aeronautics and Astronautics (AIAA), 2011
Fellow, American Physical Society (APS), 2014
Fellow, Royal Aeronautical Society (RAeS), 2017

D. Experience In Science & Technology Policy

Air Force Scientific Advisory Board (AFSAB): 2010 – 2017.

Vice Chair: Study topic development, member selection (2014 – 2016)

Study Chair: *Maturity of Directed Energy for Airborne Applications* (2016)
Briefed to: Secretary and Chief of the Air Force, House and Senate Committees, Air Force Major Commands, White House, DARPA

Technology Readiness of Hypersonic Vehicles (2014)
Briefed to: Secretary and Chief of the Air Force, Air Force Major Commands, Asst. Sec. Def, Navy, White House, DARPA, NASA

Study Member: *Test and Evaluation for Emerging USAF Needs* (2017)
Utility of Quantum Systems to the Air Force (2015)
Microsatellite Mission Applications (2013)
Extended Use of Space Sensors (2012)
Munitions for the 2025+ Environment (2011)

Air Force Research Laboratory Reviews:
Propulsion Directorate (2010)
Air Vehicles Directorate (2011)
Aerospace Systems Directorate (2012; 2013-Chair)
Space Vehicles Directorate (2013, 2015)
Office of Scientific Research (2014)
Directed Energy Directorate (2014, 2016-Vice Chair)
Munitions Directorate (2016)
Materials & Manufacturing Directorate (2016)

Institute for Defense Analyses, Alexandria, VA

Consultant, Science & Technology Policy Institute (STPI), 2016 – present
Multiple studies commissioned by OSTP, NASA, OSD, ODNI
Member, Defense Science Study Group (DSSG), 2008-2009
Member, DSSG Alumni Outreach Group, 2019-present

National Academies of Science, Engineering, & Medicine

Member, Intelligence Science & Technology Expert Group, 2016 – present
Member, Study on Strategic Long Range Cannon, 2019 – 2021
Member, Panel for Assessment of the Army Research Laboratory, 2019
Member, Review Panel for Army Research & Development Centers, 2018
Member, Panel for Assessment of NASA Aeronautics Program, 2007-08

E. Consulting

Aerojet-Rocketdyne (2023 – 2024)
Triton Systems (2022 – 2024)
Blue Origin (2022 – 2024)
HRL (2021 – 2022)
Optowares Inc. (2021)
Craft Technology (2017 – 2018, 2020 – 2021)
Blaze Tech (2020)
Astranis (2019 – 2020)
CFDRC (2012, 2019 - 2020)
MetroLaser (2019)
Institute for Defense Analyses (2006, 2008-2009, 2015 – present)
Science & Technology Policy Institute (2015 – 2018)
Ohio Aerospace Institute (2009 - 2019)
Orbion, Inc. (2018)
Microcosm, Inc. (2018)
Spectral Sciences (2012, 2017 - 2018)
SpaceX (2016, 2018)
IQM Research Institute (2015 – 2016)
Raytheon Missile Systems (2015)
Seneca Sciences (2014 – 2015)
The Aerospace Corporation (1997-98, 2001-2004, 2013-2017)
VirtualEM Inc (2013)
RockWest (2012-2013)
Cornell Technical Services (2012-2013)
Ovshinsky Solar (2011-2012)
Raytheon Professional Services (2010-2011)
CU Aerospace (2009)
ZONA Technology (2009-2010)
MilSys Technologies (2008)
Naval Research Laboratory (2008)
Mattson Technology, Inc. (2006-2007)
Aerospace Testing Alliance (2006)
Jet Propulsion Laboratory (2006)
ERC, Inc. (2000-2004, 2006)
ElectroDynamic Applications (2005-2006)
QSS, Inc (2005)

Applied Physics Laboratory (2005)
Advatech Pacific (2005-2007)
Aerojet (2004-2005)
Clear Science, Inc. (2003-2004)
SAGE Systems (2003)
Tech-X Corporation (2002)
Sverdrup Technology, Inc. Corporation (2002)
Intelsat Global Service Corporation (2002)
NASA Marshall Space Flight Center (2000)
Epion Corporation (1999)
SETI Institute (1999, 2009, 2010)
Symyx, Inc. (1999)
Applied Pulsed Power (1999)
Eaton Corporation (1998)
Los Alamos National Laboratory (1998)
Quantum Materials Technology, Inc (1997-98)
Dutch High Energy Physics Institute (1994)

F. Short Courses

"Introduction to Hypersonic Aerothermodynamics," National Institute of Aerospace, Hampton, VA, September 2007 (with G. V. Candler).

"Advanced Hypersonic Aerothermodynamics," National Institute of Aerospace, Hampton, VA, December 2007 (with G. V. Candler).

G. Selected Media Interactions

Op Ed, "High Energy Laser Weapons: How They Work and What They Are Used For," https://theconversation.com/high-energy-laser-weapons-a-defense-expert-explains-how-they-work-and-what-they-are-used-for-225071 , *The Conversation*, March 2024.

Op Ed, "Israel's Iron Dome Works Well – Here's How Hamas Got Around It," https://theconversation.com/israels-iron-dome-air-defense-system-works-well-heres-how-hamas-got-around-it-215512 , *The Conversation*, October 2023.

Op Ed, “China’s Hypersonic Missiles Threaten US Power in the Pacific,” https://theconversation.com/chinas-hypersonic-missiles-threaten-us-power-in-the-pacific-an-aerospace-engineer-explains-how-the-weapons-work-and-the-unique-threats-they-pose-206271 , *The Conversation*, May 2023.

Op Ed, “Chinese Spy Balloon Over the US,” https://theconversation.com/chinese-spy-balloon-over-the-us-an-aerospace-expert-explains-how-the-balloons-work-and-what-they-can-see-199245 , *The Conversation*, February 2023.

Op Ed, “A Game of Numbers – How Air Defense Systems Work and Why Ukraine is Eager for More Protection,” https://theconversation.com/a-game-of-numbers-how-air-defense-systems-work-and-why-ukraine-is-eager-for-more-protection-192487 , *The Conversation*, October 2022.

Op Ed, “Russians Reportedly Building a Satellite-Blinding Laser,” https://analytics.theconversation.com/us/institutions/university-of-colorado-boulder-733/1959/articles/show/186890/dates/20220728/20220728 , *The Conversation*, July 2022.

Op Ed, “How hypersonic missiles work and the unique threats they pose,” https://theconversation.com/how-hypersonic-missiles-work-and-the-unique-threats-they-pose-an-aerospace-engineer-explains-180836 , *The Conversation*, April 2022.

Op Ed, “Directed energy weapons shoot painful but non-lethal beams – are similar weapons behind the Havana syndrome?,” https://theconversation.com/directed-energy-weapons-shoot-painful-but-non-lethal-beams-are-similar-weapons-behind-the-havana-syndrome-167318 , *The Conversation*, September 2021.

Op Ed, “How universities can help counter space threats to national security,” https://gazette.com/opinion/perspective-how-universities-can-help-counter-space-threats-to-national-security/article_94f3f688-d9b3-11eb-9c19-87e1d0bf01a9.html , *Denver Gazette*, July 2021.

Op Ed, “In Support of U.S. Hypersonic System Development,” https://link.edgepilot.com/s/8c3f4472/OdSSLpnuz0KUKnP8VMhzBg?u=https://www.defensenews.com/opinion/commentary/2021/01/29/in-support-of-us-hypersonic-system-development/ , *Defense News*, February 2021.

Op Ed, “Commercial supersonic aircraft could return to the skies,” https://theconversation.com/commercial-supersonic-aircraft-could-return-to-the-skies-113022, *The Conversation*, July 2019.

Op Ed, "To Safely Explore the Solar System and Beyond, Spaceships Need to Go faster – Nuclear-Powered Rockets May Be the Answer," https://theconversation.com/to-safely-explore-the-solar-system-and-beyond-spaceships-need-to-go-faster-nuclear-powered-rockets-may-be-the-answer-137967, *The Conversation*, May 2020.

Op Ed, "Why is the Pentagon interested in UFOs?" https://theconversation.com/why-is-the-pentagon-interested-in-ufos-116714, *The Conversation*, May 2019.

Op Ed, "US, Russia, China race to develop hypersonic weapons," https://theconversation.com/us-russia-china-race-to-develop-hypersonic-weapons-114694, *The Conversation*, May 2019.

Television Interview, "Balloon Over Colorado Not a Threat, But Another What is it?," CBS, February 2024, https://www.cbsnews.com/colorado/news/balloon-over-colorado-not-threat/

Television Interview, "NASA Supersonic Jet," Canadian Broadcasting Corporation, January 2024, https://www.cbc.ca/player/play/2299340867628

Television Interview, "Explaining Israel's Iron Dome," Fox LiveNOW, October 2023, https://www.livenowfox.com/video/1301273

Television Interview: "How Does a Spy Balloon Work and How Is It Different From a Satellite," https://www.youtube.com/watch?v=mOlW0hZ6FW8 , *Deutsche Welle*, February 2023.

Television Interview: "Chinese Spy Balloon," https://www.cbsnews.com/colorado/video/aerospace-professor-says-chinese-spy-bubble-is-a-political-message/ , *CBS Colorado*, February 2023.

Television Interview: "U.S. Tech May Be Benefiting China," https://video.foxnews.com/v/6313969492112 , *Fox News National*, October 2022.

Television Interview: "Scientists Near and Far Excited for Historic Artemis Launch," https://www.cbsnews.com/colorado/news/colorado-scientists-excited-historic-artemis-launch/ *CBS News Denver*, August 2022.

Television Interview: "Scientists Near and Far Excited for Historic Artemis Launch," https://www.cbsnews.com/colorado/news/colorado-scientists-excited-historic-artemis-launch/ *CBS News Denver*, August 2022.

Television Interview: "Russians Could Spread Chaos Through Cyberattacks on Everyday Americans," https://denver.cbslocal.com/2022/02/25/russians-cyberattacks-ukraine-americans/ *CBS News Denver*, February 2022.

Television Interview: “Space Command Moving to Alabama,” https://www.9news.com/video/news/national/military-news/trump-orders-space-command-to-leave-colorado/73-e2753ce0-73c7-4d6f-aa23-49315d405a38 , *NBC 9News*, January 2021.

Television Interview: “DOD Explores the Use of Hypersonics in National Defense,” https://govmatters.tv/dod-explores-the-use-of-hypersonics-in-national-defense/ *Government Matters*, Arlington, VA, June 2019.

Podcast Interview: “The Greatest Risk Hypersonic Missiles Pose,” https://moderncto.io/iain-boyd/ , *ModernCTO Podcast*, October 2022.

Podcast Interview: “China, Russia and the U.S. Race For New Hypersonic Missiles,” https://www.abc.net.au/radio/programs/abc-news-daily/china-russia-and-the-race-for-new-hypersonic-missiles/101309104, *Australian Broadcasting Corporation*, August 2022.

Radio Interview: “Battery powered planes,” https://omny.fm/shows/kcbsam-on-demand/battery-powered-planes-could-be-operational-and-in , *KCBS Radio*, September 2022.

Radio Interview: “Artemis Launch,” *850 KOA Denver Radio*, August 2022.

Radio Interview: “Could the supersonic jet make a comeback?,” https://www.audacy.com/podcasts/kcbs-on-demand-20757/could-the-supersonic-jet-make-a-comeback-1440944484, *KCBS Radio*, May 2022.

Radio Interview: “Does a Russian Missile Test Signal a New Era of Military Activity in Space,” https://www.cpr.org/show-segment/does-a-russian-missile-test-signal-a-new-era-of-military-activity-in-space/, *Colorado Public Radio*, November 2021.

Radio Interview: “United Dips Toe in Supersonic Waters,” *KNX News Radio*, June 2021.

Radio Interview: “Virgin Galactic IPO,” Knowledge@Wharton, July 2019.

Radio Interview: “Future of Supersonic Commercial Aircraft,” Knowledge@Wharton, April 2019.

Radio Interview: “SpaceX Launch to the ISS,” Knowledge@Wharton, March 2019.

Press Interview, "How Israel is Defending Against Iran's Drone Attack," WIRED, April 2024, https://www.wired.com/story/iran-israel-drone-attack-iron-dome/

Press Interview, "The US Navy Wants Rechargeable Magazines for Lasers to Take Out Drones," Business Insider, February 2024, https://news.yahoo.com/us-navy-wants-rechargeable-magazines-223001273.html

Press Interview: "Hits and Missiles," Hamodia, February 2024, https://hamodia.com/2024/02/09/interview-hits-and-missiles/

Press Interview: "Israel's Iron Dome," Newsweek, October 2023, https://www.newsweek.com/2023/11/24/israels-high-tech-border-failure-could-happen-us-experts-say-1843772.html

Press Interview: "Putin Makes Plan for Warship Armed with Hypersonic Missiles" https://www.newsweek.com/hypersonic-missiles-how-fast-why-used-1761788 , December 2022.

Press Interview: "When is NASA's Artemis Launching and What If It Fails Its Third Attempt?" https://www.newsweek.com/artemis-rocket-launch-third-try-booster-expire-1759651 , November 2022.

Press Interview, "Russian Armed Attack on US Commercial Satellites Considered Unlikely," https://communicationsdaily.com/article/view?search_id=611892&p=1&id=1412248&BC=bc_63726c4dd3a78 , November 2022.

Press Interview, "Can Ukraine Air Defense Upgrades Stop Russian Killjoy Missile Attack," https://www.newsweek.com/can-ukraine-air-defense-upgrades-stop-russian-killjoy-missile-attack-1756131 , November 2022.

Press Interview, "American Technology Boosts China's Hypersonic Missile Technology," https://www.washingtonpost.com/national-security/2022/10/17/china-hypersonic-missiles-american-technology/ , October 2022.

Press Interview: "Colorado will play a pivotal role in the Artemis mission launching Monday," https://www.cbsnews.com/colorado/news/colorado-nasa-artemis-launch-moon-mars-missions/ , August 2022.

Press Interview: "Humans are again aiming at the moon with NASA's Artemis missions — and Colorado is at the center of it," https://www.cpr.org/2022/08/26/humans-are-again-aiming-at-the-moon-with-nasas-artemis-missions-and-colorado-is-at-the-center-of-it/ , August 2022.

Press Interview: "Engineers Face Extreme Hurdles as Hypersonic Weapon Development Accelerates," https://www.imeche.org/news/news-article/engineers-face-

extreme-hurdles-as-hypersonic-weapon-development-accelerates, *Professional Engineering Magazine*, June 2022.

Press Interview: "Inside the Race to Master Supersonic Air Travel," https://www.washingtonpost.com/technology/2022/05/28/supersonic-air-travel/ *Washington Post*, May 2022.

Press Interview: "North America vulnerable to Russian and Chinese hypersonic weapons: NORAD commander," https://www.ctvnews.ca/canada/north-america-vulnerable-to-russian-and-chinese-hypersonic-weapons-norad-commander-1.5825995 , CTV News, Canada, March 2022.

Press Interview: "Hypersonics Defense," https://www.airforcemag.com/article/hypersonics-defense/ *Air Force Magazine*, January 2022.

Press Interview: "Return of Little Rocket Man (North Korea renews Missile Testing)," *Hamodia Prime Magazine*, February 2022.

Press Interview: "New Tech Spurs Spaceplanes Vision: Halfway Around the World in 40 Minutes," https://www.upi.com/Science_News/2022/01/26/Radian-Aerospace-spaceplane/4241643127581/?u3L=1 , January 2022.

Press Interview: "Hypersonic Arms Race," https://hamodia.com/prime/hypersonic-arms-race/ , January 2022.

Press Interview: "For Hackers, Space is the Final Frontier," https://www.vox.com/recode/22598437/spacex-hackers-cyberattack-space-force , July 2021.

Press Interview: "Supersonic Airliners Hit Turbulence As Jet Developer Shuts Down," https://www.nbcnews.com/science/science-news/supersonic-airliners-hit-turbulence-jet-developer-shuts-rcna1044 , May 2021.

Press Interview: "Supersonic Travel Is About To Make A Comeback," https://www.axios.com/supersonic-air-travel-50e03cf8-e50e-4ffc-bd56-83a26877c793.html , April 2021.

Press Interview: "China Builds Advanced Weapons Using American Chip Technology," https://www.washingtonpost.com/national-security/china-hypersonic-missiles-american-technology/2021/04/07/37a6b9be-96fd-11eb-b28d-bfa7bb5cb2a5_story.html , April 2021.

Press Interview: "Missile Gap," Aerospace America, https://aerospaceamerica.aiaa.org/features/missile-gap/ , June 2020.

Press Interview: "Hypersonic Weapons," Sciencemag.org, https://www.sciencemag.org/news/2020/01/national-pride-stake-russia-china-united-states-race-build-hypersonic-weapons , January 2020.

Press Interview: "Fact Checking Trump's Iran Address," Factcheck.org, https://www.factcheck.org/2020/01/factchecking-trumps-iran-address/ , January 2020.

Press Interview: "Musk, Branson, and Bezos," The Independent (UK), https://www.independent.co.uk/news/science/elon-musk-space-jeff-bezos-richard-branson-apollo-11-moon-landing-a9011591.html, July 2019.

Press Interview: "Hypersonic Missiles Fuel New Global Arms Race," How Stuff Works, https://science.howstuffworks.com/hypersonic-missiles.htm, July 2019.

Press Interview: "Why China's Artificial Moon Probably Won't Work," Discovery Magazine, http://blogs.discovermagazine.com/d-brief/2018/10/26/china-artificial-moon-light-satellite/#.XTjUK1B7IBw, October 2018.

Press Interview: "Strange Encounters," ASEE Prism, http://www.asee-prism.org/strange-encounters/, September 2018.

Press Interview: "Hypersonic Weapons Race," Aerospace America, https://aerospaceamerica.aiaa.org/features/hypersonic-weapons-race/, June 2018.

PRESENTATIONS AND PUBLICATIONS

A. Invited Talks at Conferences and Workshops

1. "Development of High-Fidelity Multi-Disciplinary Modeling for Optimizing Hypersonic System Performance," Hypersonic Weapons Summit, Institute for Defense and Government Advancement, Bethesda, MD, September 2024.

2. "Hypersonic Vehicle Analyses: The Needs and Challenges of Multidisciplinary Simulations," AIAA Journal Keynote Lecture (Virtual), April 2024.

3. "Phenomenology for Hypersonic Vehicle Detection and Tracking," Advanced Prototyping Engineering Technology Symposium (Virtual), MIT Lincoln Laboratory, December 2023.

4. "Sensitivity Analysis for Complex Chemistry Mechanisms for Hypersonic Flows," JANNAF Conference, Salt Lake City, December 2023.

5. "Capabilities for Analysis and Testing of Very Low Earth Orbit Systems," SEASONS Conference, Laurel, MD, November 2023.

6. “Opportunities for Hypersonic Vehicle Detection and Tracking,” Hypersonic Defense Conference, Huntsville, AL, November 2023.

7. “Inlet Design Considerations for Air Breathing Electric Propulsion,” AIAA ASCEND Conference, Las Vegas, NV, October 2023.

8. “Unveiling Hypersonic Challenges – Missiles and Countermeasures,” (Virtual), COGES Conference, September 2023.

9. “Modeling of Electron Transpiration Cooling for Leading Edges of Hypersonic Vehicles,” Workshop on Electron Transpiration Cooling (Virtual), Lockheed Martin, August 2022.

10. “Development and Application of the Modified Marrone and Treanor Chemical Kinetics Model,” 32nd Rarefied Gas Dynamics Symposium (Virtual), Seoul, South Korea, July 2022.

11. “Aerothermal Models Relevant to Hypersonic Material Response,” High Temperature Materials Meeting of Experts, National Academies of Science, Washington, DC, May 2022.

12. “Computational Modeling of Hypersonic Vehicle Signatures,” Military Hypersonic Weapon Systems (virtual), Los Angeles, CA, October 2021.

13. “Interdisciplinary Hypersonics Research in Academia,” Defense Systems Information Analysis Center Webinar (virtual), September 2021.

14. “Interdisciplinary Hypersonics Research in Academia,” Hypersonic Weapons Summit (virtual), Institute for Defense and Government Advancement, April 2021.

15. “Computational Modeling of the BSUV-2 Flight Experiment,” JANNAF Meeting (virtual), December 2020.

16. “Computational Modeling of Hypersonic Vehicle Signatures,” Hypersonic Weapon Systems (virtual), London, United Kingdom, July 2020.

17. “Computational Modeling of Hypersonic Flows,” ANSYS Simulation World (virtual), June 2020.

18. “Hypersonics Research in Academia,” Hypersonic Weapons Summit, Arlington, VA, October 2019.

19. “Hypersonic Signatures Via Particle Simulations,” JASON Spring Meeting, Maclean, VA, April 2019.

20. "When Is High Fidelity Aerothermochemistry Modeling Needed?" AIAA Thermophysics Award Lecture, San Diego, CA, January 2019.

21. "Plume Simulations for Micro-Propulsion Devices," 3rd International Workshop on Micropropulsion for Cubesats, Washington, DC, July 2018.

22. "Nonequilibrium Processes in Hypersonic Rarefied Flows," 31st Symposium on Rarefied Gas Dynamics, Glasgow, United Kingdom, July 2018.

23. "Computation of Hypersonic Flow Using High Fidelity Aerothermochemistry," 7th European Conference on Computational Fluid Dynamics, Glasgow, United Kingdom, June 2018.

24. "Computational Modeling of Oxygen Chemistry for Hypersonic Flows," Hypersonic Meteoroid Entry Physics, Erice, Italy, October 2017 (Boyd, I.D., Neitzel, K. and Andrienko, D.)

25. "Modeling of Chemistry Using the Direct Simulation Monte Carlo Method," Graeme A. Bird Keynote Lecture, DSMC Workshop, Santa Fe, NM, August 2017.

26. "A Collaborative Modeling-Experimental Study of Chemical Kinetics for Pyrolyzing Ablators," AIAA Ground Testing Conference, Denver, CO, June 2017.

27. "Nonequilibrium Mechanisms in Rarefied Hypersonic Flow," AIAA Fluid Dynamics Conference, Washington, DC, June 2016.

28. "State Resolved Analyses of High Temperature Energy Transfer Processes in Oxygen," *52nd Society of Engineering Science Technical Meeting*, College Station, TX, October 2015.

29. "Parallel Computation of Nonequilibrium Gas Flows," *27th International Conference on Parallel Computational Fluid Dynamics*, Montreal, May 2015.

30. "Challenges for the Direct Simulation Monte Carlo Method," *Workshop on Moment Methods in Kinetic Theory II*, Fields Institute, University of Toronto, October 2014.

31. "Modeling of Radiation in Fluid Flow," *Center for Turbulence Research Summer Program*, Stanford University, July 2014.

32. "Computations of High-Enthalpy Laminar Air Flow Around Double Cone and Cylinder-Flare Geometries," *AIAA Thermophysics Conference*, Atlanta, GA, June 2014 (Alkandry, H., Anna, A., and Boyd, I. D.).

33. "Progress in Coupled Modeling of Flow, Surface Chemistry, and Material Response," *Radiation and Gas-Surface Interaction Phenomena in High-Speed Re-entry*, Urbana-Champaign, IL, April 2014.

34. "Detailed Analyses of Oxygen Thermochemistry Based on State-Resolved Kinetics," *AIAA SciTech Meeting*, National Harbor, MD, January 2014.

35. "Simulation of a Pulsed Atomic Oxygen Beam," *SPIE Optical Engineering & Applications Conference*, San Diego, California, August 2013 (Carron, N., Boyd, I.D., et al.)

36. "Computation of Hypersonic Flow Using the Direct Simulation Monte Carlo Method," *21st AIAA CFD Conference*, San Diego, California, June 2013.

37. "Progress and Future Prospects for Particle-Based Simulation of Hypersonic Flow," *43rd AIAA Fluid Dynamics Conference*, San Diego, California, June 2013 (Schwartzentruber, T.E. and Boyd, I.D.).

38. "Approaches for Emulating the Boltzmann Equation When Particle Simulation Becomes Inefficient," *Workshop on Issue in Solving the Boltzmann Equation for Aerospace Applications*, Providence, Rhode Island, June 2013.

39. "Status and Challenges for Coupled Modeling of Flow, Surface Chemistry, and Material Response," *Gordon Conference on Atmospheric Re-entry Physics*, Ventura, California, February 2013.

40. "State-resolved Analysis of Thermochemical Nonequilibrium for H_2 and N_2," *1st International Symposium on Hypersonic Aerothermodynamics–Recent Advances*, Bangalore, India, December 2012 (Kim, J.G. and Boyd, I.D.).

41. "Hybrid Particle-Continuum Numerical Methods for Aerospace Applications," *Models and Computational Methods for Rarefied Flows*, Von Karman Institute for Fluid Mechanics, Brussels, Belgium, January 2011 (Boyd, I.D. and Deschenes, T.R.).

42. "Simulation of Electric Propulsion Thrusters," *Models and Computational Methods for Rarefied Flows*, Von Karman Institute for Fluid Mechanics, Brussels, Belgium, January 2011.

43. "Hybrid Particle-Continuum Methods for Nonequilibrium Gas and Plasma Flows," *27th International Symposium on Rarefied Gas Dynamics*, Asilomar, CA, July 2010.

44. "Development of Hybrid DSMC-Continuum Methods for Nonequilibrium Gas and Plasma Flows," *Direct Simulation Monte Carlo: Theory, Methods, and Applications*, Santa Fe, NM, September 2009.

45. "Strongly Coupled Computation of Material Response and Nonequilibrium Flow for Hypersonic Ablation," (with Alexandre Martin), *AFOSR/NASA/SNL Technical*

Interchange Meeting on Ablation Modeling, Santa Fe, NM, April 2009.

46. "Simulation of Non-Continuum Hypersonic Flows," *NASA Fundamental Aeronautics Program Annual Meeting*, Atlanta, GA, October 2008.

47. "Direct Simulation Monte Carlo for Atmospheric Entry. 1. Theoretical Basis and Physical Models," *Nonequilibrium Hypersonic Flows*, Von Karman Institute for Fluid Mechanics, Brussels, Belgium, September 2008.

48. "Direct Simulation Monte Carlo for Atmospheric Entry. 2. Code Development and Application Results," *Nonequilibrium Hypersonic Flows*, Von Karman Institute for Fluid Mechanics, Brussels, Belgium, September 2008.

49. "Direct Simulation Monte Carlo for Atmospheric Entry," *Shortcourse on Hypersonic Entry and Cruise Vehicles*, Stanford University, CA, July 2008.

50. "Hybrid Computation of Nonequilibrium Gas and Plasma Flows," *3rd ASTRONUM Conference*, St. John, Virgin Islands, June 2008.

51. "Flow and Radiation Analyses of Stardust Entry," *3rd Reentry Emission Signatures Workshop*, NASA Ames Research Center, CA, May 2008.

52. "Monte Carlo Simulation of Particle Radiation in High Altitude Solid Rocket Plumes," *43rd AIAA Joint Propulsion Conference*, Cincinnati, OH, July 2007.

53. "Particle Simulation of Chemical Nonequilibrium in Hypersonic Gas Flows," *232nd Meeting of the American Chemical Society*, San Francisco, CA, September 2006.

54. "Multi-Scale Modeling of Hypersonic Flows," *Hypersonics Workshop*, Minneapolis, MN, October 2005.

55. "Lessons Learned from Modeling In-Space Hall Thruster Plume Experiments," *High-Power Electric Propulsion Test Platform User Workshop*, Houston, TX, May 2005.

56. "Numerical Simulation of Hall Thruster Plasma Plumes," *9th Space Charging Technology Conference*, Tokyo, Japan, April 2005.

57. "Sensitivity Analysis of Near Field Simulations of Plasma Plumes," *Mini Conference on Plasma Propulsion*, Division of Plasma Physics 46th Annual Meeting, Savannah, Georgia, November 2004.

58. "Review of Micro-Propulsion Ablative Devices," *International Symposium on Energy Conversion Fundamentals*, Istanbul, Turkey, June 2004.

59. "Hybrid Particle-Continuum Computation of Nonequilibrium Hypersonic Flows," *NASA Marshall Spring Fluids Workshop*, Huntsville, Alabama, April 2004.

60. “Hybrid Particle-Continuum Computation of Multi-Scale Nonequilibrium Gas Flows," *Particle-Based Mesoscale Simulation Techniques Symposium*, University of Minneapolis, Minnesota, April 2004.

61. "Direct Simulation Monte Carlo Method: A Particle Method for Nonequilibrium Gas Flows," *Particle-Based Mesoscale Simulation Techniques Symposium*, University of Minneapolis, Minnesota, March 2004.

62. "Hybrid Particle-Continuum Computation of Nonequilibrium Hypersonic Flows," *Workshop on Multi-Algorithm Methods for Multi-Scale Simulations*, Lawrence Livermore National Laboratory, California, January 2004.

63. "Hybrid Particle-Continuum Computation of Nonequilibrium Hypersonic Flows," *American Mathematical Society Southeastern Section Fall Meeting*, Chapel Hill, North Carolina, October 2003.

64. "The Information Preservation Method: A DSMC Variant With Reduced Statistical Fluctuations," *Workshop on "40 Years of the DSMC Method",* Milan, Italy, June 2003.

65. "Simulation of Micro-Scale Aerodynamics," *41st AIAA Aerospace Sciences Meeting*, Reno, Nevada, January 2003.

66. "Predicting Breakdown of the Continuum Equations Under Rarefied Flow Conditions," *23rd International Symposium on Rarefied Gas Dynamics*, Whistler, Canada, July 2002.

67. "Particle Methods for Micro-Scale Gas Flows," *32nd AIAA Fluid Dynamics Conference*, St. Louis, Missouri, June 2002.

68. "Present Status of Numerical Simulations in Electric Propulsion," *8th International Workshop on Combustion and Propulsion*, Pozzuoli, Italy, June 2002.

69. "Simulation of the Plasma Plume Generated by a Micro-Laser-Ablation Thruster," *SPIE High-Power Laser Ablation Conference*, Taos, New Mexico, April 2002.

70. "Hall Thruster Far Field Plume Modeling and Comparison to Express Flight Data," *AIAA 40th Aerospace Sciences Meeting*, Reno, Nevada, January 2002.

71. "Particle Simulation of Micro-Scale Gas Flows," *AIAA 39th Aerospace Sciences Meeting*, Reno, Nevada, January 2001.

72. "Modeling of Rarefied Flow Around a Meteoroid," *Leonid MAC Workshop*, Tel Aviv, Israel, April 2000.

73. "A Review of Hall Thruster Plume Modeling," *AIAA 38th Aerospace Sciences Meeting*, Reno, Nevada, January 2000.

74. "Particle Simulation of Gas Flows for MEMS Devices," *American Institute of Chemical Engineers Annual Meeting*, Dallas, Texas, November 1999.

75. "Numerical Modeling of Hall Thruster Plumes," *CNES Workshop on Plasma Propulsion Plumes*, Toulouse, France, September 1999.

76. "Nonequilibrium Chemistry Modeling in Rarefied Hypersonic Flows," *AIAA Thermophysics Conference*, Norfolk, Virginia, June 1999.

77. "Parallel Monte Carlo Modeling of a Plasma Etch Reactor," *50th Gaseous Electronics Conference*, Madison, Wisconsin, October 1997.

78. "Currents Strengths and Limitations of the Direct Simulation Monte Carlo Method," *Workshop on Mathematical Methods for Kinetics Problems*, Berlin, Germany, September 1997.

79. "Direct Simulation of Ultra-Violet Emission From the Hydroxyl Radical," *AIAA Thermophysics Conference*, Atlanta, Georgia, June 1997.

80. "Monte Carlo Simulation of Nonequilibrium Flow in Low Power Hydrogen Arcjets," *AIAA Fluid Dynamics Conference*, New Orleans, Louisiana, June 1996.

B. Books and Book Contributions

1. Boyd, I.D. and Schwartzentruber, T.E., *Nonequilibrium Gas Dynamics and Molecular Simulation*, Cambridge University Press, March 2017.

2. Esposito, F., Macdonald, R., Boyd, I.D., Neitzel, K., and Andrienko, D.A., "Heavy-Particle Elementary Processes in Hypersonic Flows," *Hypersonic Meteoroid Entry Physics*, edited by G. Colonna, M. Capitelli, and A. Laricchiuta, IOP, 2019.

3. Boyd, I.D., "Thrusters: Pulsed Plasmas," *Encyclopedia of Plasma Technology*, edited by J.L. Shohet, CRC Press, 2016, pp. 1484-1491.

4. Boyd, I.D., "Computation of Hypersonic Nonequilibrium Flows using the Direct Simulation Monte Carlo Method," *Hypersonic Nonequilibrium Flows: Fundamentals and Recent Advances*, edited by E. Josyula, AIAA, 2015, pp. 45-102.

5. Boyd, I.D. and Agarwal, R. K., "Computational Modeling of Rarefied Gas Flows," *Encyclopedia of Aerospace Engineering*, edited by R. Blockley and W. Shyy, Wiley, 2010.

6. Boyd, I.D., "Non-Continuum Hypersonic Flows," *Encyclopedia of Aerospace Engineering*, edited by R. Blockley and W. Shyy, Wiley, 2010.

7. Boyd, I.D., “Direct Simulation Monte Carlo for Atmospheric Entry. Part I: Theoretical Basis and Physical Models,” *Hypersonic Entry and Cruise Vehicles*, Edited by N.N. Mansour, T. Magin, P. Moin, and O. Chazot, Von Karman Institute for Fluid Dynamics, 2009.

8. Boyd, I.D., “Direct Simulation Monte Carlo for Atmospheric Entry. Part II: Code Development and Application Results,” *Hypersonic Entry and Cruise Vehicles*, Edited by N.N. Mansour, T. Magin, P. Moin, and O. Chazot, Von Karman Institute for Fluid Dynamics, 2009.

9. Boyd, I.D., "Multi-Scale Modeling of Hypersonic Gas Flows," *Handbook of Materials Modeling*, edited by S. Yip, Springer Press, Heidelburg, 2005, pp. 2811-2818.

10. Boyd, I.D., "Nonequilibrium Chemistry Modeling in Rarefied Hypersonic Flows," *Chemical Dynamics in Extreme Environments*, edited by R. A. Dressler, World Scientific Press, Singapore, 2001, pp. 81-137.

C. Refereed Articles Published in Archival Journals

1. Chan, W.H.R., Hara, K. and Boyd, I.D., “Effects of Multi-Dimensionality and Energy Exchange on Electrostatic Current-Driven Plasma Instabilities and Turbulence,” *Journal of Plasma Physics*, Vol. 90, 2024, Article xxxx.

2. Aiken, T.T. and Boyd, I.D., “State-resolved modeling of electronic excitation in weakly ionized oxygen mixtures,” *Physical Review E*, Vol. 109, 2024, Article 045203.

3. Aiken, T.T. and Boyd, I.D., “Sensitivity Analysis of Ionization in Two-Temperature Models of Hypersonic Air Flows,” *Journal of Thermophysics and Heat Transfer*, Vol. 38, 2024, pp. 478-490.

4. Aiken, T.T. and Boyd, I.D., “Collision-Radiative Modeling of Shock-Heated Nitrogen,” *Journal of Applied Physics*, Vol. 135, 2024, Article 093301.

5. Rataczak, J., Chaudhry, R.S., MacMahon, J., and Boyd, I.D., “Investigation of Surface-Catalycity Effects on Hypersonic Glide Vehicle Trajectory Optimization,” *Journal of Spacecraft and Rockets*, Vol. 61, 2024, pp. xx-xx.

6. Horing, J.A., Boyd, I.D., and Maute, K.K, “Fully Coupled Analysis of Aerothermoelastic Deformation of a Scramjet Inlet,” *Journal of Propulsion and Power*, Vol. 40, 2024, pp. 181-192.

7. Aiken, T.T. and Boyd, I.D., “Two-Temperature Modeling of Nonequilibrium Relaxation and Dissociation in Shock-Heated Oxygen,” *Journal of Thermophysics and Heat Transfer*, Vol. 37, 2023, pp. 723-732.

8. Chan, W.H.R. and Boyd, I.D., "Grid-point Requirements for Direct Kinetic Simulation of Weakly Collisional Plasma Plume Expansion," *Journal of Computational Physics*, Vol. 475, 2022, Article 111861.

9. Chan, W.H.R. and Boyd, I.D., "Enabling Direct Kinetic Simulation of Dense Plasma Plume Expansion for Laser Ablation Plasma Thrusters," *Journal of Electric Propulsion*, Vol. 1, 2022, pp. 1-26.

10. Holloway, M.E., Chaudhry, R.MS, and Boyd, I.D., "Assessment of Hypersonic Double-Cone Experiments for Validation of Thermochemistry Models," *Journal of Spacecraft and Rockets*, Vol. 59, 2022, pp. 389-400.

11. Holloway, M.E., Hanquist, K.M., and Boyd, I.D., "Sensitivity Analysis of Thermochemical Kinetics Modeling for Hypersonic Air Flows," *Journal of Thermophysics and Heat Transfer*, Vol. 36, 2022, pp. 584-593.

12. Sawicki, P., Chaudhry, R.S., and Boyd, I.D., "Influence of Chemical Kinetics Models in Plasma Generation in Hypersonic Flight," *AIAA Journal*, Vol. 60, 2022, pp. 31-40.

13. Meyer, M.E., Byrne, M.P., Boyd, I.D., Jorns, B.A., "Quantifying Uncertainty in Predictions of Spacecraft Erosion by a Hall Thruster," *Journal of Spacecraft and Rockets*, Vol. 59, 2021, pp. 988-1000.

14. Campbell, N.S., Hanquist, K., Morin, A., Meyers, J., and Boyd, I.D., "Evaluation of Computational Models for Electron Transpiration Cooling," *Aerospace*, Vol. 8, 2021, pp. 243-261.

15. Boyd, I.D. and Josyula, E., "Analysis of Associative Ionization Rates for Hypersonic Flows," *Journal of Thermophysics and Heat Transfer*, Vol. 35, 2021, pp. 484-493.

16. Dang, D.Z., Stern, E.C., and Boyd, I.D., "Structural Response Modeling of a Woven Thermal Protection System," *Journal of Thermophysics and Heat Transfer*, Vol. 35, 2021, pp. 288-295.

17. Dang, D.Z., Stern, E.C., and Boyd, I.D., "Inferring Thermal Conductivity of a Dual-layer Woven Thermal Protection System Using Cross-validation," *Thermal Science and Engineering Progress*, 2021, p. 100904.

18. Vazsonyi, A.R., Hara, K., and Boyd, I.D., "Non-Monotonic Double Layers and Electron Two-Stream Instabilities Resulting From Intermittent Ion Acoustic Wave Growth," *Physics of Plasmas*, Vol. 27, 2020, Article 112303.

19. Chen, S.Y. and Boyd, I.D., "Boundary Layer Thermochemical Analysis During

Passive and Active Oxidation of Silicon Carbide," *Journal of Thermophysics and Heat Transfer*, Vol. 34, 2020, pp. 504-515.

20. Holloway, M.E., Hanquist, K.M., and Boyd, I.D., "Assessment of Thermochemistry Modeling for Hypersonic Flow Over a Double Cone," *Journal of Thermophysics and Heat Transfer*, Vol. 34, 2020, pp. 538-547.

21. Streicher, J.W., Krish, A., Hanson, R.K., Hanquist, K.M., Chaudhry, R.S., and Boyd, I.D., "Shock-Tube Measurements of Coupled Vibration-Dissociation Time-Histories and Rate Parameters in Oxygen and Argon Mixtures From 5,000-10,000 K," *Physics of Fluids*, Vol. 32, 2020, Article 076103.

22. Dragnea, H.C., Ortega, A.L., Kamhawi, H., and Boyd, I.D., "Simulation of a Hall Effect Thruster Using Krypton Propellant," *Journal of Propulsion and Power*, Vol. 36, 2020, pp. 335-345.

23. Raisanen, A.L., Hara, K., and Boyd, I.D., "Two-dimensional hybrid-direct kinetic simulation of a Hall thruster discharge plasma," *Physics of Plasmas*, Vol. 26, 2019, Article 123515.

24. Mackey, L.E. and Boyd, I.D., "Assessment of Hypersonic Flows on Aero-Optics," *AIAA Journal*, Vol. 57, 2019, pp. 3885-3897.

25. Cross, P.G. and Boyd, I.D., "Conjugate Analyses of Ablation in Rocket Nozzles," *Journal of Spacecraft and Rockets*, Vol. 56, 2019, pp. 1593-1610.

26. Chen, S.Y., Boyd, I.D., Martin, N.C., and Fletcher, D.G., "Modeling of Emission Spectra in Nonequilibrium Plasmas for Testing Pyrolyzing Ablators," *Journal of Thermophysics and Heat Transfer*, Vol. 33, 2019, pp. 907-916.

27. Eyi, S., Hanquist, K.M., and Boyd, I.D., "Shape Optimization of Reentry Vehicles to Minimize Heat Loading," *Journal of Thermophysics and Heat Transfer*, Vol. 33, 2019, pp. 785-796.

28. Eyi, S., Hanquist, K.M., and Boyd, I.D., "Aerothermodynamic Design Optimization of Hypersonic Vehicles," *Journal of Thermophysics and Heat Transfer*, Vol. 33, 2019, pp. 392-406.

29. Hanquist, K.M. and Boyd, I.D., "Plasma Assisted Cooling of Hot Surfaces on Hypersonic Vehicles," *Frontiers in Physics*, Vol. 7, Article 9, 2019. [Editor's Choice for Plasma Physics, 2019]

30. Chen, S.Y., and Boyd, I.D., "Chemical Equilibrium Analysis of Silicon Carbide Oxidation in Oxygen and Air," *Journal of the American Ceramic Society*, Vol. 102, 2019, pp. 4272-4284.

31. Andrienko, D.A. and Boyd, I.D., "Kinetic Models of Oxygen Thermochemistry Based on Quasi-Classical Trajectory Analysis," *Journal of Thermophysics and Heat Transfer*, Vol. 2, 2018, pp. 904-916.

32. Jun, E. and Boyd, I.D., "Assessment of the LD-DSMC Method for Hypersonic Rarefied Flow," *Computers and Fluids*, Vol. 166, 2018, pp. 123-138.

33. Cusson, S. E., Georgin, M. P., Dragnea, H. C., Dale, E. T., Dhaliwal, V., Boyd, I. D., and Gallimore, A. D., "On Channel Interactions in Nested Hall Thrusters," *Journal of Applied Physics,* Vol. 123, 2018, Article 133303.

34. Cross, P.G. and Boyd, I.D., "Reduced Reaction Mechanism for Rocket Nozzle Ablation Simulations," *Journal of Thermophysics and Heat Transfer*, Vol. 32, 2018, pp. 429-439.

35. Andrienko, D.A. and Boyd I.D., "Vibrational Energy Transfer and Dissociation in O_2-N_2 Collisions at Hyperthermal Temperatures," *Journal of Chemical Physics*, Vol. 148, 2018, Article 084309.

36. Boyd, I.D. and Josyula, E., "Detailed Analysis of Vibrational Nonequilibrium of Molecular Oxygen in Shock-Heated Flow," *Physical Review Fluids*, Vol.2, 2017, Article 123401.

37. Weaver, A.B. and Boyd, I.D., "Unsteady Simulations of Rocket Plume Expansions in Geostationary Earth Orbit," *Journal of Spacecraft and Rockets*, Vol. 54, 2017, pp. 1258-1266.

38. Boyd, I.D. and Lal, B., "On-Orbit Assembly Will Deliver Major Benefits In Coming Decades," *The Space Journal ROOM*, Vol. 12, 2017, pp. 10-16.

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281. Keidar, M. and Boyd, I.D., "Analyses of the Anode Region of a Hall Thruster Channel," AIAA Paper 2002-4107.

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283. Spanjers, G.G, Bromaghim, D.R., White, D., Schilling, J.H., Bushman, S.S., Antonsen, E.L., Burton, R.L., Keidar, M., and Boyd, I.D., "AFRL MicroPPT Development for Small Spacecraft Propulsion," AIAA Paper 2002-3974, July 2002.

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287. Boyd, I.D., "Hall Thruster Far Field Plume Modeling and Comparison to Express Flight Data," AIAA paper 2002-0487, January 2002.

288. Candler, G.V., Nompelis, I., Druguet, M.-C., Holden, M.S., Wadhams, T. P., Boyd, I.D., and Wang, W.-L., "CFD Validation for Hypersonic Flight: Hypersonic Double-Cone Flow Simulations," AIAA Paper 2002-0581, January 2002.

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293. Boyd I.D. and Falk, M.L., "A Review of Spacecraft Material Sputtering by Hall Thruster Plumes," AIAA Paper 2001-3353, July 2001.

294. Katz, I. et al., "A Hall Effect Thruster Plume Model Including Large-Angle Elastic Scattering," AIAA Paper 2001-3355, July 2001.

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314. Gimelshein, S.F., Boyd, I.D., Sun, Q., and Ivanov, M., "DSMC Modeling of Vibration-Translation Energy Transfer in Hypersonic Rarefied Flows," AIAA Paper 99-3451, June 1999.

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317. Cai, C.-P., Fan, J., Boyd, I.D. and Candler, G.V., "Direct Simulation Methods for Micro-Channel Flows," AIAA Paper 99-3801, June 1999.

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321. VanGilder, D.B. and Boyd, I.D., “Analysis of Collision Phenomena in Hall Thruster Plumes,” IEPC Paper 99-076, October 1999.

322. Garrigues, L., Boyd, I.D., and Boeuf, J.-P., “Computation of Hall Thruster Performance,” IEPC Paper 99-098, October 1999.

323. Keidar, M., Boyd, I.D., and Beilis, I.I., “Particulate Interaction with Plasma in a Teflon Pulsed Plasma Thruster,” IEPC Paper 99-213, October 1999.

324. Keidar, M., Boyd, I.D., and Beilis, I.I., “A Model of an Electrical Discharge in a Co-Axial Pulsed Plasma Thruster,” IEPC Paper 99-214, October 1999.

325. George, J. D. and Boyd, I.D., "Numerical Investigation of Hydrogen Plume Flows Using Unstructured Grids," AIAA Paper 98-2448, June 1998.

326. Kannenberg, K. C. and Boyd, I.D., "Three Dimensional Monte Carlo Simulations of Plume Impingement," AIAA Paper 98-2755, June 1998.

327. Karipides, D.P., Boyd, I.D. and Caledonia, G.E., "Detailed Simulation of Surface Chemistry Leading to Spacecraft Glow," AIAA Paper 98-2848, June 1998.

328. Longo, S. and Boyd, I.D., "Coupled PIC/MCC and State-to-State Continuum Model of a Parallel-Plate RF Hydrogen Discharge," AIAA Paper 98-2984, June 1998.

329. Burton, R.L. et al., "Overview of US Academic Programs in Electric Propulsion," AIAA Paper 98-3182, July 1998.

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332. Boyd, I.D., "Computation of the Plume of the D55 Hall Thruster Plume," AIAA Paper 98-3798, July 1998.

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335. VanGilder, D.B., Font, G.I., and Boyd, I.D., "Hybrid DSMC-PIC Computation of an Ion Thruster Plume," IEPC Paper 97-182, September 1997.

336. Boyd, I.D., Phillips, W.D., and Levin, D.A., "Sensitivity Studies for Prediction of Ultra-Violet Radiation in Nonequilibrium Hypersonic Bow-Shock Waves," AIAA Paper 97-0131, Reno, NV, January 1997.

337. Holden, M.S., Harvey, J.K., Boyd, I.D., George, J., and Horvath, T., “Experimental and Computational Studies of the Flow Over a Sting-Mounted Planetary Probe Configuration,” AIAA Paper 97-0768, January 1997.

338. Font, G.I. and Boyd, I.D., "Numerical Study of the Effects of Reactor Geometry on a Chlorine Helicon Plasma Etch Reactor," Paper 96-0591, AIAA Aerospace Sciences Meeting, Reno, NV, January 1996.

339. Boyd, I.D., Bose, D., and Candler, G.V., "Monte Carlo Modeling of Nitric Oxide Formation Based on Quasi-Classical Trajectory Calculations," Paper 96-1845, AIAA Thermophysics Conference, New Orleans, LA, June 1996.

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341. Kannenberg, K.C. and Boyd, I.D., "Development of a 3D Parallel DSMC Code for Plume Impingement Studies," Paper 96-1848, AIAA Thermophysics Conference, New Orleans, LA, June 1996.

342. Boyd, I.D., "Monte Carlo Simulation of Nonequilibrium Flow in Low Power Hydrogen Arcjets," (invited) Paper 96-2022, AIAA Fluid Dynamics Conference, New Orleans, LA, June 1996.

343. Muntz, E.P., Lutfy, F., and Boyd, I.D., "Study of Reacting, High-Energy Flows Using Pulsed Electron-Beam Fluorescence," AIAA Paper 96-1986, AIAA Fluid Dynamics Conference, New Orleans, LA, June 1996.

344. Wysong, I.J., Pobst, J.A., and Boyd, I.D., "Comparisons of Hydrogen Atom Measurements in an Arcjet Plume With DSMC Predictions," Paper 96-3185, AIAA Joint Propulsion Conference, Orlando, FL, July 1996.

345. Boyd, I.D., "Monte Carlo Simulation of Hydrogen Arcjet Flow Fields," Paper 96-3297, AIAA Joint Propulsion Conference, Orlando, FL, July 1996.

346. Beiting, E.J., Welle, R.P., Boyd, I.D., and VanGilder, D.B., "Specific Impulse Measurements for a Resistojet: Comparison with Monte Carlo Calculations," Paper 96-3307, AIAA Joint Propulsion Conference, Orlando, FL, July 1996.

347. Boyd, I.D., Karipides, D.P., Candler, G.V., and Levin, D.A., "Dissociation Modeling at High Altitude and Application to the Skipper Flight Experiment," Paper 95-0709, AIAA Aerospace Sciences Meeting, Reno, NV, January 1995.

348. Dietrich, S. and Boyd, I.D., "Parallel Implementation on the IBM SP-2 of the Direct Simulation Monte Carlo Method," AIAA Paper 95-2029, 29th AIAA Thermophysics Conference, San Diego, CA, June 1995.

349. Boyd, I.D. and Srinivasan, A., "Design of Thermochemical Nonequilibrium Experiments for the LENS Hypersonic Facility," AIAA Paper 95-2006, 29th AIAA Thermophysics Conference, San Diego, CA, June 1995.

350. Kannenberg, K.C., Dietrich, S., and Boyd, I.D., "Development of an Object-Oriented Parallel DSMC Code for Plume Impingement Studies," AIAA Paper 95-2052, 29th AIAA Thermophysics Conference, San Diego, CA, June 1995.

351. Karipides, D.P., Boyd, I.D., and Levin, D.A., "Prediction of Ultraviolet Emissions in Rarefied Hypersonic Flow," AIAA Paper 95-2091, 29th AIAA Thermophysics Conference, San Diego, CA, June 1995.

352. Chen, G. and Boyd, I.D., "Statistical Error Analysis for the Direct Simulation Monte Carlo Technique," AIAA Paper 95-2316, 26th AIAA Fluid Dynamics Conference, San Diego, CA, June 1995.

353. Beiting, E.J., Garman, L., Boyd, I.D., and VanGilder, D.B., "CARS Velocity and Temperature Measurements in a Hydrogen Resistojet: Comparison with Monte Carlo Calculation," Paper 95-2382, AIAA Joint Propulsion Conference, San Diego, CA, July 1995.

354. Butler, G.W., Boyd, I.D., and Cappelli, M.A., "Nonequilibrium Flow Phenomena in Low Power Hydrogen Arcjets," Paper 95-2819, AIAA Joint Propulsion Conference, San Diego, CA, July 1995.

355. Boyd, I.D., VanGilder, D.B., Beiting, E.J., Cohen, R.B., Pencil, E.J., and Hirsch, S.D.,"Numerical and Experimental Studies of Hydrogen and Nitrogen Flows in a Resistojet," Paper 95-20, 24th International Electric Propulsion Conference, Moscow, Russia, September 1995.

356. Levin, D.A., Candler,. G.V., Boyd, I.D., et al., "In-Situ Measurements of Transitional and Continuum Flow UV Radiation from Small Satellite Platforms," Paper 94-0248, AIAA Aerospace Sciences Meeting, Reno, NV, January 1994.

357. Dietrich, S. and Boyd, I.D., "A Scalar Optimized Parallel Implementation of the DSMC Technique," Paper 94-0355, AIAA Aerospace Sciences Meeting, Reno, NV, January 1994.

358. Nijhawan S., Candler, G.V. and Boyd, I.D., "Improved Continuum Modeling of Low-Density Hypersonic Flows," Paper 94-1956, AIAA Thermophysics Conference, Colorado Springs, CO, June 1994.

359. Boyd, I.D., Srinivasan, A., Muntz, E.P., Hanson, R.K. and Holden, M.S., "Thermochemical Nonequilibrium Design Calculations for Detailed Hypervelocity Experiments in the LENS Facility," Paper 94-2097, AIAA Thermophysics Conference, Colorado Springs, CO, June 1994.

360. Boyd, I.D., Chen, G. and Candler, G.V., "Predicting Failure of the Continuum Fluid Equations in Transitional Hypersonic Flows," Paper 94-2352, AIAA Fluid Dynamics Conference, Colorado, Springs, CO, June 1994.

361. Muntz, E.P., Boyd, I.D., and Ketsdever, A., "Rarefied Flow Testing in the 1990's: Measuring Those Phenomena That Are Difficult to Compute," Paper 94-2639, AIAA Thermophysics Conference, Colorado Springs, CO, June 1994.

362. Penko, P.F., Boyd, I.D. and Howell, T.G., "Preliminary Experimental and Numerical Studies of Plume Impingement on a 100 Degree Cone," Paper 94-3142, AIAA Joint Propulsion Conference, Indianapolis, IN, June 1994.

363. Kannenberg, K.C. and Boyd, I.D., "Monte Carlo Computation of Rarefied Supersonic Flow Into a Pitot Probe," Paper 94-3301, AIAA Joint Propulsion Conference, Indianapolis, IN, June 1994.

364. Boyd, I.D. and Gokcen, T., "Computation of Axisymmetric and Ionized Flows Using Particle and Continuum Methods," Paper 93-0729, AIAA Aerospace Sciences Meeting, January 1993.

365. Lumpkin, F.E., Boyd, I.D., and Venkatapathy, E., "Comparison of Continuum and Particle Simulations of Expanding Rarefied Flows," Paper 93-0728, AIAA Aerospace Sciences Meeting, January 1993.

366. Candler, G.V., Boyd, I.D., et al., "Continuum and DSMC Analysis of Bow Shock Flight Experiments," Paper 93-0275, AIAA Aerospace Sciences Meeting, January 1993.

367. Boyd, I.D., Cappelli, M.A., and Beattie, D.R., "Monte Carlo Computation of Nozzle and Plume Flows of a Low-Power Hydrogen Arcjet," Paper 93-2529, AIAA Joint Propulsion Conference, Monterey, CA, June 1993.

368. Penko, P.F., Riley, B., Boyd, I.D., "Assessment of Three Numerical Methods for the Computation of a Low-Density Plume Flow," Paper 93-2530, AIAA Joint Propulsion Conference, Monterey, CA, June 1993.

369. Boyd, I.D., Pham-Van-Diep, G.C., and Muntz, E.P., "Monte Carlo Computation of Nonequilibrium Flow in a Hypersonic Iodine Windtunnel," Paper 93-2871, AIAA Thermophysics Conference, Orlando, FL, July 1993.

370. Pham-Van-Diep, G.C., Muntz, E.P., and Boyd, I.D., "Measurement of Vibrational Population Distributions in a Free-Jet Flow of Chemically Reacting Iodine Vapor and Comparisons With Monte Carlo Predictions," Paper 93-2996, AIAA Fluid Dynamics Conference, Orlando, FL, July 1993.

371. Boyd, I.D., Beattie, D.R., and Cappelli, M.A., "Monte Carlo and Experimental Studies of Chamber Effects for a Low-Power Hydrogen Arcjet," International Electric Propulsion Conference, Seattle, WA, September 1993, .

372. Zelesnik, D., Penko, P.F., and Boyd, I.D., "Effects of Nozzle Geometry on Plume Expansion for Small Thrusters," International Electric Propulsion Conference, Seattle, WA, September 1993.

373. Boyd, I.D. and Gokçen, T., "Assessment of Thermochemical Models for Continuum and Particle Simulations of Hypersonic Flow," Paper 92-2954, AIAA Thermophysics Conference, Nashville, TN, July 1992.

374. Boyd, I.D. and Whiting, E.E., "Decoupled Predictions of Radiative Heating in Air Using a Particle Simulation Method," Paper 92-2971, AIAA Plasmadynamics Conference, Nashville, TN, July 1992.

375. Penko, P.F., Boyd, I.D., Meissner, D.L., and DeWitt, K.J., "Analysis and Measurement of a Small Nozzle Plume in Vacuum," Paper 92-3108, AIAA Joint Propulsion Conference, Nashville, TN, July 1992.

376. Jafry, Y.R., Vanden Beukel, J., Boyd, I.D., and DeBra D.B., "Impingement Calculations for Ultra-Low Density Helium Thrusters," 12th IFAC Symposium on Automatic Control in Aerospace, Ottobrun, Germany, September 1992.

377. Haas, B.L. and Boyd, I.D., "Models for Vibrationally-Favored Dissociation Applicable to a Particle Simulation," Paper 91-0774, AIAA Aerospace Sciences Conference, Reno, NV, January 1991.

378. Boyd, I.D., Penko, P.F., and Meissner, D.L., "Numerical and Experimental Investigations of Rarefied Nozzle and Plume Flows of Nitrogen," Paper 91-1363, AIAA Thermophysics Conference, Honolulu, HI, June 1991.

379. Penko, P.F., Boyd, I.D., Meissner, D.L., and DeWitt, K.J., "Pressure Measurements in a Low-Density, Nozzle Plume for Code Verification," Paper 91-2110, AIAA Joint Propulsion Conference, Sacramento, CA, June 1991.

380. Boyd, I.D., "Assessment of Chemical Nonequilibrium in Rarefied Hypersonic Flow," Paper 90-0145, AIAA Aerospace Sciences Meeting, January 1990.

381. Boyd, I.D., Penko, P.F. and Carney, L.M., "Efficient Monte Carlo Simulation of Rarefied Flow in a Small Nozzle," Paper 90-1693, AIAA Thermophysics Conference, Seattle, WA, June 1990.

382. Boyd, I.D., "Direct Simulation of Rotational and Vibrational Nonequilibrium," Paper 89-1880, AIAA Thermophysics Conference, Buffalo, NY, June 1989.

383. Boyd, I.D. and Stark, J.P.W., "Modelling of a Small Hydrazine Thruster Plume in the Transition Flow Regime," Paper 88-2631, AIAA Thermophysics Conference, San Antonio, TX, June 1988.

F. Research Seminars

1. Naval Air Warfare Center Air Defense (virtual), August 2024.

2. Stanford University, Mechanical Engineering, CA, April 2024.

3. Lawrence Livermore National Laboratory, Livermore, CA, November 2023.

4. NASA Entry, Descent, & Landing Seminars (virtual), July 2023.

5. Lockheed Martin Corporation (virtual), May 2023.

6. Oxford University, Oxford, United Kingdom, May 2023.

7. Air Force Research Laboratory (virtual), Materials & Manufacturing Directorate, April 2023.

8. National Defense University, Washington, DC, March 2023.

9. Lawrence Livermore National Laboratory, Livermore, CA, November 2022.

10. University of Colorado, Aerospace Engineering, Boulder, CO, March 2022.

11. California Institute of Technology, Aeronautics, Pasadena, CA, October 2021.

12. University of Colorado, Plasma Physics, Boulder, CO, September 2020.

13. The Aerospace Corporation, Launch, Strike, & Range, El Segundo, CA, May 2019.

14. University of Colorado, Aerospace Engineering, Boulder, CO, January 2019.

15. University of Illinois, Aerospace Engineering, Urbana-Champaign, IL, December 2018.

16. Raytheon Air & Space Systems, Rosslyn, VA, November 2018.

17. Texas A & M University, Aerospace Engineering, College Station, TX, September 2018.

18. Orbital ATK, Dulles, VA, March 2018.

19. University of Maryland, Mechanical Engineering, College Park, MD, February 2018.

20. George Washington University, Mechanical & Aerospace Engineering, Washington, DC, January 2018.

21. Purdue University, Aeronautics & Astronautics, West Lafayette, IN, December 2017.

22. Applied Physics Laboratory, Johns Hopkins University, Laurel, MD, November 2017.

23. Naval Research Laboratory, Space Technology Division, Washington, DC, October 2017.

24. University of Kentucky, Mechanical Engineering, Lexington, KY, October 2017.

25. Future In-Space Operations Tele-Seminar, September 2017.

26. RAND Corporation, Arlington, VA, May 2017.

27. University of Colorado, Aerospace Engineering, Boulder, CO, April 2017.
28. Aerospace Corporation, El Segundo, CA, March 2014.
29. Air Force Research Laboratory, Propulsion Directorate, Wright-Patterson AFB, OH, May 2011.
30. University of Illinois Urbana-Champaign, Aerospace Engineering, IL, September 2010.
31. NASA Ames Research Center, Moffett Field, CA, July 2010.
32. Air Force Research Laboratory, Propulsion Directorate, Wright-Patterson AFB, OH, August 2009.
33. Air Force Research Laboratory, Air Vehicles Directorate, Wright-Patterson AFB, OH, May 2009.
34. Georgia Institute of Technology, Aerospace Engineering, Atlanta, GA, November 2008.
35. Ohio State University, Aerospace Engineering, Columbus, OH, November 2008.
36. Lawrence Berkeley National Laboratory, Scientific Computing, Berkeley, CA, May 2007.
37. NASA Ames Research Center, Moffett Field, CA, May 2007.
38. University of Virginia, Mechanical & Aerospace Engineering, Charlottesville, VA, March 2007.
39. Lawrence Livermore National Laboratory, Applied Scientific Computing, Livermore, CA, February 2007.
40. University of California Los Angeles, Mechanical & Aerospace Engineering, Los Angeles, CA, February 2007.
41. Air Force Research Laboratory, Propulsion Directorate, Edwards Air Force Base, CA, December 2006.
42. NASA Ames Research Center, Moffett Field, CA, November 2006.
43. Stanford University, Mechanical Engineering, CA, October 2006.
44. Princeton University, Mechanical & Aerospace Engineering, Princeton, NJ, February 2006.
45. Michigan Technological University, Mechanical Engineering, Houghton, MI, Dec. 2005.

46. Queen Mary University of London, Department of Engineering, England, April 2005.
47. University of Michigan, Aerospace Engineering, Ann Arbor, MI, October 2004.
48. Virginia Tech, Aerospace & Oceanic Engineering, Blacksburg, VA, October 2004.
49. University of Glasgow, Aerospace Engineering, Scotland, July 2004.
50. NASA Marshall Space Flight Center, Huntsville, AL, April 2004.
51. Aerojet Corporation, Redmond, WA, January 2004.
52. University of Michigan, Aerospace Engineering, September 2003.
53. Johns Hopkins University, Applied Physics Laboratory, Laurel, MD, April 2003.
54. University of Maryland, Aerospace Engineering, College Park, MD, April 2003.
55. University of Michigan, Mathematics, Ann Arbor, MI, January 2003.
56. Air Force Research Laboratory, Propulsion Directorate, Edwards Air Force Base, CA, October 2002.
57. Air Force Research Laboratory, Air Vehicles Directorate, Wright-Patterson AFB, OH, April 2002.
58. Arnold Engineering and Development Center, Arnold AFB, TN, February 2002.
59. Mechanical Engineering, Vanderbilt University, Nashville, TN, September 2001.
60. NASA Marshall Space Flight Center, Advanced Propulsion Center, Huntsville, AL, April 2001.
61. TRW, Propulsion Division, Redondo Beach, CA, January 2001.
62. California Institute of Technology, Aeronautics, Pasadena, CA, October 2000.
63. Jet Propulsion Laboratory, Advanced Propulsion, Pasadena, CA, October 2000.
64. Aerospace Corporation, Los Angeles, CA, October 2000.
65. Ohio State University, Mechanical Engineering, Columbus, OH, April 2000.
66. University of Minnesota, Aerospace Engineering, Minneapolis, MN, April 1999.
67. Air Force Research Laboratory, Space Vehicles Directorate, Hanscom Air Force Base, Boston, MA, March 1999.
68. Universite Paul Sabatier, Plasma Physics, Toulouse, France, January 1999.
69. University of Illinois-Urbana Champaign, Aeronautics & Astronautics, IL, December 1998.
70. NASA Lewis Research Center, Cleveland, OH, November 1998.

71. University of Michigan, Aerospace Engineering, Ann Arbor, MI, October 1998.
72. Worcester Polytechnic Institute, Mechanical Engineering, MA, September 1998.
73. Brown University, Applied Mathematics, Providence, RI, September 1998.
74. CERCA, Montreal, Canada, May 1998.
75. Pennsylvania State University, Aerospace Engineering, State Park, PA, March 1997.
76. Princeton University, Applied Physics, Princeton, NJ, December 1996.
77. NASA Lewis Research Center, Cleveland, OH, September 1996.
78. Stanford University, Mechanical Engineering, CA, April 1996.
79. NASA Ames Research Center, Moffett Field, CA, April 1996.
80. Air Force Research Laboratory, Space Vehicles Directorate, Hanscom Air Force Base, Boston, MA, March 1996.
81. Ohio State University, Mechanical Engineering, Columbus, OH, October 1995.
82. NASA Lewis Research Center, Cleveland, OH, August 1995.
83. Physical Sciences Incorporated, Andover, MA, August 1995.
84. Aerospace Corporation, Los Angeles, CA, July 1995.
85. Air Force Phillips Laboratory, Edwards Air Force Base, CA, July 1995.
86. Massachusetts Institute of Technology, Space Propulsion Group, Cambridge, MA, April 1995.
87. Syracuse University, Mechanical and Aerospace Engineering, NY, December 1994.
88. Science Applications International Corporation, McLean, VA, August 1994.
89. NASA Lewis Research Center, Cleveland, OH, May 1994.
90. NASA Ames Research Center, Moffett Field, CA, March 1994.
91. NASA Langley Research Center, Hampton, VA, January 1994.
92. NASA Lewis Research Center, Cleveland, OH, July 1993.
93. CALSPAN Corporation, Buffalo, NY, July 1993.
94. NASA Ames Research Center, Moffett Field, CA, April 1993.
95. Stanford University, Mechanical Engineering, Stanford, CA, November 1992.
96. University of Southern California, Aerospace Engineering, Los Angeles, CA, November 1992.

97. University of Virginia, Aerospace Engineering, Charlottesville, VA, April 1992.
98. Massachusetts Institute of Technology, Aeronautics and Astronautics, Cambridge, MA, April 1992.
99. University of California San Diego, Applied Mechanics and Engineering Science, San Diego, CA, March 1992.
100. NASA Lewis Research Center, Cleveland, OH, March 1992.
101. Pennsylvania State University, Aerospace Engineering, PA, March 1992.
102. Cornell University, Mechanical and Aerospace Engineering, NY, February 1992.
103. Stanford University, Aeronautics and Astronautics, CA, October 1991.
104. CNRS, Laboratoire D'Aerothermique, Meudon, France, April 1991.
105. NASA Lewis Research Center, Cleveland, OH, March 1991.
106. University of Southern California, Aerospace Engineering, CA, March 1990.
107. University of California, Mechanical Engineering, Berkeley, CA, August 1989.
108. University of Kaiserslautern, Applied Mathematics, Germany, September 1987.