# KEITH D. GOODFELLOW

14514 129th Ave NE
Kirkland, WA 98034
e-mail: kdgoodfellow@sbcglobal.net

(cell) (661) 210-6024
(office) (425) 936-5226

**CAREER OBJECTIVE**

Senior research, development or design position in plasma systems, electric or chemical rocket propulsion systems, or spacecraft systems.

**PROFESSIONAL WORK EXPERIENCE**

CHIEF ENGINEER, ARCJET THRUSER AND ION ENGINE SYSTEMS Oct. 2013 to Present
Aerojet Rocketdyne Space Systems, Redmond, Washington

Technical lead engineer for the Arcjet Thruster System including thruster, power cable, relay box and Power Conditioning Unit (PCU). Responsible for maintaining high technical quality for both development and production programs while maintaining cost and schedule. Technical lead for identifying new materials and processes for product improvement and replacing obsolete components. Technical lead for product line Engineering Review Boards and customer review meeting.

Test lead and Subject Matter Expert (SME) for NEXT-C ion engine system. Supported thruster development and flight testing. Lead System Integration Testing (Thruster, PCU, DCIU) for DART mission and coordinated activities with NASA and APL. Served as chair or board member on Engineering Review Boards.

Member of the Electric Propulsion Products Team responsible for technology and personnel development plans, strategic planning, enterprise level risks and opportunities, and infrastructure investments.

Mentored junior level engineers about thruster physics, operation, design and testing, and career development. Member of the Space Systems training coordination group. Developed Arcjet Thruster Systems short course.

Subject Matter Expert (SME) and technical support engineer in the areas of Hall thrusters, plasma physics, high-temperature gas dynamics, rarefied gas dynamics, thermal systems, orbital mechanics, spacecraft systems and testing of electric propulsion thrusters.

ADJUNCT ASSOCIATE PROFESSOR OF ASTRONAUTICS PRACTICE Jan. 2000 to Present
Department of Astronautical Engineering
University of Southern California, Los Angeles, California
Courses of Instruction:
***Advanced Spacecraft Propulsion**, ASTE 572*, Developed and instructed a graduate level course covering rocket fundamentals review, heat transfer, nozzle flow, nuclear physics, electrical physics, rarefied gas dynamics, plasma physics, electric and nuclear systems. Course is taught each year and is one of the most popular technical elective classes in the department.

***Spacecraft Propulsion**, ASTE 470*, Co-developed and instructed a senior/graduate level course covering rocket fundamentals, combustion, nozzle flow, heat transfer, propellant tanks and feed systems, chemical and electric propulsion systems. Course is taught each year and is often the highest student rated course in the department.

***Introduction to Astronautics and Space Environment**, ASTE 280*, Co-developed and instructed a sophomore level course covering orbital mechanics, propulsion, attitude dynamics, reentry, and introduction to spacecraft systems (power, telecommunications, and structures). Taught intermittently.

Ph.D. thesis co-adviser for 3 students and committee advisor/member for additional 7 Ph.D. and Masters degree students. Advised several undergraduate (senior) and Masters student projects.

Mentor for the USC Student Rocket Propulsion Lab. Supported solid propellant and hybrid propellant rocket design, fabrication and testing.

**PROFESSIONAL WORK EXPERIENCE (continued)**

AERONAUTICAL ENGINEER SENIOR STAFF Apr. 2004 to Sept. 2013
Advanced Development Programs (Skunk Works)
Lockheed Martin Aeronautics Company, Palmdale, California

Lead engineer and project manager for research and development programs in the areas of plasma systems (glow discharges, dielectric barrier discharges and nanosecond pulsed systems), and proof-of-concept technology development projects. Developed potentially disruptive technologies; managed budget, schedule, and a small technically diverse team; reported to customers; and prepared proposals. Mentored junior level engineers.

Designed, developed, and managed a proof-of-concept evaluation laboratory including a unique high-altitude (up to 200 kft) steady-state subsonic wind tunnel (6 inch by 9 inch test section) and a unique large (14 ft diameter by 70 ft long) high-altitude simulation chamber.

Subject Matter Expert (SME) and technical support engineer in the areas of propulsion, high-temperature gas dynamics, rarefied gas dynamics, orbital mechanics, thermal systems, low-observable technologies and materials, aircraft systems engineering and patent applications. Supported Hall Effect Thruster propulsion activities on the AEHF satellites for LM Space Systems Company. Supported aircraft vehicle designs and systems trade studies.

Performed Radar Cross Section analysis (method of moments and Xpatch software) aircraft components evaluating geometry and material effects. Performed radar cross-sectional testing of vehicle components (CompuQuest software). Coordinated custom pole model development, fabrication, installation, and testing.

SENIOR ENGINEER Aug. 1988 to Apr. 2004
Advanced Propulsion Technology Group
Jet Propulsion Laboratory (JPL), Pasadena, California

Laboratory manager and lead test engineer for the Electric Propulsion Test laboratory: Lead setup and facility operation of several successful long-duration thruster tests including: over 30,000 hours of operation on the Deep Space 1 (DS1) flight spare gridded ion engine (just under 5 years of test-time without chamber venting, world record), 8200 hour test of the DS1 engineering model thruster, several Hall Effect Thrusters (HET), and arcjet thrusters. Developed Hall Effect thrusters, gridded ion engines, electromagnetic thrusters, and arc heated thrusters and plasma sources for both government and industrial customers. Team member of DS1 spacecraft ion engine flight operations, solar-thermal-vacuum testing, and ion engine system integration teams. Integrated DS1 ion engine flight-spare hardware into long-duration test facility. Developed data acquisition and control systems (hardware and software) for long duration thruster testing. Lead day-to-day operations of the electric propulsion test laboratory: including instrumentation, parts fabrication and purchases, facility modifications, safety, environmental compliance, and facility and machine tools maintenance. Team member for development of two large vacuum test facilities for steady-state high-power (>20 kW and >500 kW) thruster performance and long-duration testing.

Project manager: managed successful multi-year programs including: performing technical work, securing follow-on funding, reporting to sponsors, and directing technical activities and finances. Project 1 focused on the experimental and theoretical development of a 3 to 10 kW ammonia arcjet thruster, and integration with the ELITE/STAR flight experiment propulsion system. Project 2 developed advanced MPD thrusters focusing on understanding the fundamentals of cathode/plasma interactions for the purpose of developing long-life cathodes.

Developed numerical models for electrode heat transfer and electrode plasma sheath phenomena, gridded ion engine plumes, ion engine accelerator grid erosion and spacecraft mission performance. Developed finite difference, finite volume, and DSMC numerical methods. Performed Finite Element Method analysis (structure and thermal).

Propulsion member for Team-X spacecraft design team for 2 mission designs using hydrazine monopropellant systems. Supported several spacecraft mission designs and technology proposal developments. Co-developed microwave beamed sail concept. JPL lead and SBIR manager for a multi-year development program of low-sputter-yield high-emissivity carbon materials and fiber-composite materials with small business.

**PROFESSIONAL WORK EXPERIENCE (continued)**

GRADUATE RESEARCH ASSISTANT Aug. 1986 to July 1988
Thermal Sciences and Propulsion Center (now Zucrow Labs)
Purdue University, West Lafayette, Indiana
Developed a computer model for simulation of the plasma physics processes in the cathode region of a MagnetoPlasmaDynamic (MPD) electromagnetic thruster as part of a Masters Degree thesis. Developed customized numerical routines for solving highly nonlinear differential equations.

ASSOCIATE ENGINEER June 1986 to Aug. 1986
Morton Thiokol (now Orbital ATK), Elkton Division, Elkton, Maryland
Developed computer models for solid propellant rocket motors and for solid propellant combustion.

DRAFTSMAN July 1983 to June 1986
E-Systems (now Moog Aircraft), Montek Division, Salt Lake City, Utah
Created new mechanical and electrical drawings in compliance with military specifications, by both traditional and computerized methods including printed circuit board layouts. Incorporated changes to existing documents.

**PROFESSIONAL ORGANIZATIONS**

American Institute of Aeronautics and Astronautics, Senior Member, Electric Propulsion Technical Committee Member 1998 – 2003 and 2017 - present
American Society of Mechanical Engineers, Member
Paper reviewer for AIAA Journal of Propulsion and Power, AIAA Journal of Spacecraft and Rockets, Physics of Fluids, IEEE Transactions in Plasma Science, European Journal of Applied Physics, and JANNAF journals.

**EDUCATION**

UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, California Sept. 1990 to May 1996
Ph.D. in Aerospace Engineering
Thesis Title: A Theoretical and Experimental Investigation of Cathode Processes in Electric Thrusters.
Research in electric propulsion and plasma physics with course work in plasma physics, rarefied and physical gas dynamics, optical gas diagnostics, fluid dynamics, advanced mathematics, and quantum mechanics.
Lecturer and course co-developer for senior/graduate level course in rocket propulsion (now ASTE 470).
GPA: 3.67 on a 4.0 scale

PURDUE UNIVERSITY, West Lafayette, Indiana Sept. 1986 to Aug. 1988
Master of Science in Mechanical Engineering
Thesis Title: Plasma Processes at a Cathode Spot in a Magneto-Plasma-Dynamic Thruster
Research in electric propulsion and plasma physics with course work in rocket propulsion, hypersonic aerodynamics, fluid dynamics, heat transfer, thermodynamics, numerical analysis and vector calculus.
GPA: 5.85 on a 6.0 scale

UNIVERSITY OF UTAH, Salt Lake City, Utah Sept. 1981 to June 1986
Graduated Magna Cum Laude with Bachelor of Science in Mechanical Engineering and a Physics Minor.
Relevant coursework: structural mechanics, dynamics, vibrations, mechanisms and machine design, finite element analysis, project design, incompressible and compressible fluid dynamics, heat transfer, thermodynamics, statistical thermodynamics, aerodynamics, rotor design, propulsion, acoustics, thermal systems design, modern physics, electronics, automatic controls, engineering law, numerical methods and statistics.
GPA: 3.58 on a 4.0 scale

UTAH TECHNICAL COLLEGE, Salt Lake City, Utah June 1982 to June 1986
Graduated with High Honors with a Certificate in Engineering Drafting and Design Technology
GPA: 3.95 on a 4.0 scale

**EDUCATION (continued)**

**Industry Technical Courses:** Principles of Project Management, Project Management 101, Team Leadership, Principles of Critical Path Methodology, Space Systems I and II, GPS Spacecraft Systems, Spacecraft Constellation Design, Spacecraft Attitude Determination and Control, Design of Space Missions and Systems Engineering, Design of Low-Cost Space Missions, Aircraft Conceptual Design, Hypersonic Propulsion, Air-Breathing Engine Inlets, NPSS Propulsion System Design, Low-Observables for Designers, Low-Observable Vehicle Design, Xpatch Electromagnetic Simulation, HFSS, CATIA V5 CAD Fundamentals and Surface Design Expert, Aircraft Stress Analysis, Aeroeleasticity, Mass Properties, Aircraft Structures, Spreadsheet Engineering and Technical Writing.

**Audited Graduate Level Courses (USC):** advanced electromagnetics, reflector antennas, optics, linear algebra and complex variables, liquid propellant rockets, spacecraft systems, combustion, and boundary layer theory.

**HONORS**

Group Award, Los Angeles Engineers Council, NEXT-C Flight Hardware Acceptance Tests, Mar. 2021
Special Recognition Award, Energetic class, Aerojet Rocketdyne, NEXT Flight Ion Engine Tests, Oct. 2020
Group Award, Los Angeles Engineers Council, XR-5 HCT life test, Mar. 2019
Special Recognition Award, Launch class, Aerojet Rocketdyne, XR-5 HCT life test, Sept. 2018
Special Recognition Award, Ignition class, Aerojet Rocketdyne, Engineers Week lecture and support, May 2018
Special Recognition Award, Energetic class, Aerojet Rocketdyne, Relay requalification for PCUs, Sept. 2017
Jack Wyld Leadership Award Nomination, Aerojet Rocketdyne, Nov. 2015
Special Recognition Award, Launch class, Aerojet Rocketdyne, Arcjet Thruster Test Chamber Activation, July 2015
SRA Special Recognition Team Award, Lockheed Martin Aeronautics, F-22 flight test project, June 2012
SRA Special Recognition Team Award, Lockheed Martin Aeronautics, P801 project, May 2011
Significant Incident Record and Individual SPOT Award, Lockheed Martin Aeronautics, Nov. 2010
SRA Special Recognition Team Award, Lockheed Martin Aeronautics, June 2007
Individual SPOT Awards, Lockheed Martin Aeronautics: Apr. 2008, Dec. 2007, Oct. 2005, Sept. 2005 and July 2004.
Outstanding Paper Award, Space Technology and Applications International Forum (STAIF) 2001, coauthor
NASA "Turning Goals into Reality" group award, NSTAR Ion Engine Team
NASA Award for Excellence, Group Award, Deep Space I Ion Propulsion System.
NASA Award for Excellence, Group Award, 8000 Hour Endurance Test of the NSTAR Ion Engine.
JPL, Notable Value-Added Award, Commitment to Excellence, DS1 Grid-Clear Characterization
JPL, Notable Value-Added Award, Commitment to Excellence, Data Acquisition System Development
Tau Beta Pi Engineering Honor Fraternity
Pi Tau Sigma Mechanical Engineering Honor Fraternity, University of Utah chapter president, 1985-1986
Mechanical Engineering Departmental Scholarship, University of Utah, 1985-1986
Honors at Entrance Scholarship, University of Utah, 1981-1982

**Skills:** Microsoft (Word, PowerPoint, Excel and Project), FORTRAN, LabView, CATIA V5 CAD, Photoshop, Matlab, CompuQuest, HFSS, XPatch, Finite Element Methods (structural and thermal), flight hardware assembly and testing, soldering, machine shop (lathe, endmill, drill press).

**PUBLICATIONS**

Over 30 proprietary or restricted technical reviews and reports.

**Journals, Book Chapters and Patents**

Thorium Migration Effects on Cathode Temperature in Electric Thrusters, D. Codron, K. Goodfellow and D. Erwin, AIAA Journal of Propulsion and Power, Vol. 29, No. 1, January 2013.

Solid Thoriated Tungsten Cathode Arc Discharges for Electrically Propelled Spacecraft, Codron, D., Goodfellow, K.D., Downey, R.T., and Erwin, D.A., IEEE Transactions on Plasma Science, Vol. 40, Issue 7, July 2012.

Single-Channel Hollow Cathodes in 5-20 eV Argon Discharge for Spacecraft Thruster Applications, R. Downey, P. Giuliano, K. Goodfellow and D. Erwin, IEEE Transactions on Plasma Science, Vol. 39, No 4, April 2011.

**PUBLICATIONS (continued)**

Cathode Sheath Voltage Models Hydrazine Arcjets, J. Lu, H. Krier, R. L. Burton and K. D. Goodfellow, *Journal of Thermophysics and Heat Transfer*, Vol. 12, No. 2, April-June 1998.

Space-Charge-Limited Emission from Field Emission Cathodes for Electric Propulsion and Tether Applications, C Marrese, J. Wang, A. Gallimore, and K Goodfellow, Chapter 18, AIAA *Progress in Astronautics and Aeronautics* Vol. 187, 2000.

Patent pending: Hybrid Plasma Fuel Engine Rocket, patent number US 2009/0229240.

**Technical Conference Papers and Presentations**

NEXT-C Flight Ion System Status, J. Fischer, B. Ferraiuolo, J. Monheiser, K. Goodfellow, A. Hoskins, R. Myers, J. Bontempo, J. McDade, T. O'Malley, G. Soulas, R. Shastry, and M. Gonzalez, AIAA-2020-3604, AIAA Propulsion and Energy Forum, August 2020.

NEXT Single String Integration Tests in Support of the Double Asteroid Redirection Test Mission, R. Thomas, M. Aulisio, A. Badger, C. Heistand, D. Thomson, R. Liang, J. John, K. Goodfellow and J. Bontempo, IEPC-2019-853, 36th International Electric Propulsion Conference, September 2019.

Development and Flight Operations of a Hydrazine Arcjet System Operating at 100 Volts Input Voltage, D. Zube, K. Goodfellow, and C. Hearn, IEPC-2017-305, 35th International Electric Propulsion Conference, October 2017.

Electric Propulsion Systems at Aerojet Rocketdyne, AIAA Pacific Northwest Technical Symposium, November 2016. Presentation only.

History and Recent Developments of Aerojet Rocketdyne's MR-510 Hydrazine Arcjet Systems, D. Zube, A. Hakim, K. Goodfellow, and B. Welander, Space Propulsion Conference, Cologne Germany, 2014

Results of Experimental Studies on Throium Migration in Electric Thrusters, D. Codron, K. Goodfellow and D. Erwin, AIAA 2012-4277, 48th Joint Propulsion Conference, July 2012.

Results of Experimental Study of Hollow Cathodes in High Current Plasma Discharge, R. Downey, P. Giuliano, K. Goodfellow, and D. Erwin, IEPC-2009-224, 31st International Electric Propulsion Conference, September 2009.

Status of the Extended Life Test of the Deep Space 1 Flight Spare Ion Engine after 30,000 hours of Operation, A. Sengupta, J. R. Brophy and K. D. Goodfellow, AIAA 2003-4558, 39th Joint Propulsion Conference, July 2003.

The Status of Ion Propulsion Development and Implementation at JPL in 2003, J. R. Brophy, J. E. Polk, A. Sengupta, S. N. Synder, I. Katz and K. D. Goodfellow, AIAA 2003-4711, 39th Joint Propulsion Conference, July 2003.

Development and Testing of Carbon-Based Ion optics for 30 cm Ion thrusters, S. N. Synder, J. R. Brophy, K. D. Goodfellow, and D. Fitzgerald, AIAA 2003-4716, 39th Joint Propulsion Conference, July 2003.

An End-to-End Test of a Simulated Nuclear Electric Propulsion System, M. Van Dyke, I. Hrbud, K.Goodfellow, AIAA 2002-3819, 38th Joint Propulsion Conference, July 2002.

Lightweight Ion Engine Body, Y. Yamaki, T. Knowles and K. Goodfellow, IEPC-01-095, 27th International Electric Propulsion Conference, October 2001.

Microwave Beam-Driven Sail Flight Experiments, J. Benford, G. Benford, K. Goodfellow, R. Perez, H. Harris, and T. Knowles, presented at Space Technology and Applications International Forum (STAIF) Conference, 2001.

Performance Characteristics of the NSTAR Ion Thruster During an On-Going Long Duration Ground Test, Anderson, J.R., Goodfellow, K.D., Polk, J.E., Rawlin, V.K. and Sovey, J.S., Aerospace Conference Proceedings, 2000 IEEE Vol. 4., 2000.

**PUBLICATIONS (continued)**

An Experimental and Theoretical Analysis of the Grid Clearing Capability of the NSTAR Ion Propulsion System, K. D. Goodfellow, G. B. Ganapathi and J. F. Stocky, AIAA 99-2859, 35th Joint Propulsion Conference, June 1999.

Results of an On-going Long Duration Ground Test of the DS1 Flight Spare Ion Engine, J. R. Anderson, K. D. Goodfellow, J. E. Polk, R. F. Shotwell, V. K. Rawlin, J. S. Sovey and M. J. Patterson, AIAA 99-2857, 35th Joint Propulsion Conference, June 1999.

Field Emission Array Cathodes for Electric Propulsion Systems, C. M. Marrese, A. D. Gallimore, J. E. Polk, K. D. Goodfellow, and K. L. Jensen, AIAA 98-3484, 34th Joint Propulsion Conference, July 1998.

Collisionless Cathode Sheath Models to Predict Power Distribution in 1 kW Hydrazine Arcjet Thrusters, J. Lu, H. Krier, R. L. Burton and K. D. Goodfellow, AIAA 97-3206, 33rd Joint Propulsion Conference, July 1997.

Operation of a Solid-Rod Cathode in a Low-Pressure Discharge, K. D. Goodfellow, AIAA 96-3205, 32nd Joint Propulsion Conference, July 1996

Methods for Cryopumping Xenon, C. E. Garner, J. R. Polk, J. R. Brophy and K. D. Goodfellow, AIAA 96-3206, 32nd Joint Propulsion Conference, July 1996.

Theoretical Investigation of Cathode Operation in High-Power Arcjets, K. D. Goodfellow, AIAA 95-3061, 31st Joint Propulsion Conference, July 1995.

Experimental Verification of a High-Current Cathode Thermal Model, K. D. Goodfellow and J. E. Polk, AIAA 95-3062, 31st Joint Propulsion Conference, July 1995.

ELITE/STAR Arcjet System End-to-End Test, K. D. Goodfellow, AIAA 94-3244, 30th Joint Propulsion Conference, June 1994.

Segmented Ion Engine Operation and Performance, J. R. Brophy, J. Mueller, L. C. Pless, M. Tierney, K. D. Goodfellow and J. R. Anderson, AIAA 94-2851, 30th Joint Propulsion Conference, June 1994.

Theoretical Operation of Solid Rod Cathodes, K. D. Goodfellow and J. E. Polk, AIAA 94-3132, 30th Joint Propulsion Conference, June 1994.

Experimental Investigation of Solid Rod Cathode Operation, J. E. Polk, K. D. Goodfellow and T. J. Pivirotto, AIAA 94-3131, 30th Joint Propulsion Conference, June 1994.

Design and Development of a 3- to 10- kW Ammonia Arcjet, K. D. Goodfellow and J. E. Polk, IEPC-93-078, 23rd International Electric Propulsion Conference, Sept. 1993.

High Current Cathode Thermal Behavior, Part I: Theory, K. D. Goodfellow and J. E. Polk, IEPC-93-030, 23rd International Electric Propulsion Conference, Sept. 1993.

High Current Cathode Thermal Behavior, Part II: Experiments, J. E. Polk and K. D. Goodfellow, IEPC-93-029, 23rd International Electric Propulsion Conference, Sept. 1993.

Performance Evaluation and Life Testing of the SPT-100, C. E. Garner, J. E. Polk, L. C. Pless, K. D. Goodfellow, and J. R. Brophy, IEPC-93-091, 23rd International Electric Propulsion Conference, Sept. 1993.

Ammonia Arcjet Behavior in a Cyclic Endurance Test at 10 kW, J. E. Polk and K. D. Goodfellow, IAF-92-0612, 43rd Congress of the International Astronautical Federation, Aug. 1992.

Applied-Field Magnetoplasmadynamic Engine Developments, K. D. Goodfellow, T. J. Pivirotto and J. E. Polk, AIAA-92-3833, 28th Joint Propulsion Conference, June 1992.

**PUBLICATIONS (continued)**

Results of a 1462 Hour Ammonia Arcjet Endurance Test, J. E. Polk and K. D. Goodfellow, AIAA-92-3293, 28th Joint Propulsion Conference, June 1992.

Endurance Test of an Ammonia Arcjet at 10 kW, J. E. Polk and K. D. Goodfellow, AIAA-91-068, 22nd International Electric Propulsion Conference, Oct. 1991.

An Experimental and Numerical Investigation of an Applied-Field Magnetoplasmadynamic Space Propulsion Engine, T. J. Pivirotto and K. D. Goodfellow, AIAA-91-074, 22nd International Electric Propulsion Conference, Oct. 1991.

Throttling Capability of a 30 kW Class Ammonia Arcjet, K. D. Goodfellow and J. Polk, AIAA-91-2577, 27th Joint Propulsion Conference, June 1991.

Development of a 100 kW Class Radiation-cooled, Applied-field Magnetoplasmadynamic Engine, T. J. Pivirotto and K. D. Goodfellow, AIAA-90-2556, 21st International Electric Propulsion Conference, July 1990.

Cathode Erosion Tests for 30 kW Arcjets, W. D. Deininger, A. Chopra, and K. D. Goodfellow, AIAA-89-2264, 25th Joint Propulsion Conference, July 1989.

Cathode Processes in an MPD Arcjet, K. D. Goodfellow and S. N. B. Murthy, IEPC-88-072, 20th International Electric Propulsion Conference, Oct. 1988

Electrode Processes and MPD Thruster Operation, K. D. Goodfellow and S. N. B. Murthy, AIAA-88-3207, 24th Joint Propulsion Conference, June 1988.

Observability of Heat Transfer to MPD Thruster Electrodes, F. Pourki, K. Goodfellow, R. Shoureshi and S. N. B. Murthy, AIAA-87-1070, 19th International Electric Propulsion Conference, May 1987.

**Invited Talks**

"In-Space Propulsion", University of Washington, senior design class, Oct. 2019.
"Energy and Propulsion in Aerospace," Seattle University ENGR 305 class guest lecture, Jan. 2018
"Electric Propulsion at Aerojet Rocketdyne," Seattle IEEE Power Electronics Lecture Series, Mar. 2017
"Electric Propulsion at Aerojet Rocketdyne," AIAA Pacific Northwest Technical Symposium, Nov. 2016
"Propulsion Options for Interstellar Travel," USC Engineering Lecture series, 2009
"Advanced Propulsion for Spacecraft," USC Undergraduate Honors Colloquium, April 2007