

# CHUNPEI CAI

Dept. of Mechanical Engineering-Engineering Mechanics  
R.L. Smith Building, RM 1013  
1400 Townsend Drive  
Michigan Technological University  
Houghton, MI 49931

Tel: (906) 487-3286  
Fax: (906) 487-4822  
E-mail: ccai@mtu.edu

---

## EDUCATION

- 01/2002-12/2005: Ph.D. in Aerospace Engineering, University of Michigan, Ann Arbor, Michigan
- 09/1997-08/1999: M.Sc. in Mechanical Engineering, Cornell University, Ithaca, New York
- 09/1990-07/1994: B.Eng. in Naval Architecture, Harbin Engineering University, Harbin, China

## CITIZENSHIP

U.S. citizen

## EMPLOYMENT AND APPOINTMENT HISTORY

- 01/16-current: Associate Professor, Department of Mechanical Engineering and Engineering Mechanics, Michigan Technological University, Houghton, Michigan
- 08/2013-12/2015: Associate Professor, Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, New Mexico
- 08/08-08/2013: Assistant Professor, Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, New Mexico
- 11/2005-08/2008: Senior CFD Specialist and Developer, ZONA Tech. Inc., Scottsdale, Arizona
- 04/1999-11/2005: Senior Software Engineer, Altair Engineering Inc., Troy, Michigan

## RESEARCH AND TEACHING INTERESTS

1. Nonequilibrium flow modelling and simulations (including hypersonic and micro-flows);
2. Propulsion, space propulsion and electro-sprays;
3. Plasma physics & applications, e.g., space vehicle-space environment interactions;
4. New gas-kinetic CFD scheme development & implementations, large scale parallel computations;
5. Flow-structure interactions (e.g. aero-elasticity), multiple disciplinary optimizations (MDO).

## HONOR AND AWARDS

1. Air Force Summer Fellow, AFRL, ABQ: 2015, 2016, 2017, 2018, 2019
2. Outstanding referee, International Journal of Vacuum, 2014
3. Early tenure and early promotion, New Mexico State University, 2012
4. Dean's appreciation award, college of engineering, New Mexico State University, 2011
5. Sage fellowship, Cornell University, 1997-1998

## SELECTED REFERRED JOURNAL ARTICLES

- j70. Li, J., **Cai, C.**, and Li, Z., "Efficient DSBGK Simulations of Low Speed Thermal Transpiration Gas Flows Through Micro-channels," *International Communications in Heat and Mass Transfer*, Vol.119, pp.104924, 2020. <https://doi.org/10.1016/j.icheatmasstransfer.2020.104924>.
- j69. Cai, S., **Cai, C.**, and Li, J., Highly Dilute Gas Flows Over An Ellipse, *Physics of Fluids*, 097104, 2020. doi: 10.1063/5.0019745
- j68. VanDevender, J. P., Buchenauer, J., **Cai, C.**, VanDevender, A.P., and Ulmen, B., Radio Frequency Emissions From Dark-Matter-Candidate Magnetized Quark Nuggets Interacting With Matter, *Scientific Reports*, vol.10, 13756, 2020.

- j67. Cai, S., **Cai, C.**, and Li, J., Highly Dilute Gas Flows Through A Non-Isothermal Planar Micro-Channel, *Physics of Fluids*, Vol.32, 072006, 2020. <https://doi.org/10.1063/5.0013451>
- j66. Zhang, K., Cai, S., **Cai, C.**, and Cooke, D., A Versatile Serial and Parallel Full Scale Particle-In-Cell Simulation Package for Space Plasma Simulations, *Physics of Plasmas*, Vol.86, No.3, 3905860308, 2020.
- j65. He, X., and **Cai, C.**, Stability Analysis on Nonequilibrium Supersonic Flat Plate Boundary Layer Flow With Slip Velocity, *Fluids*, special issue on “Turbulence and Transitional Modeling of Aerodynamic Flows”, Vol.4, 2019. <https://doi:10.3390/fluids4030142>.
- j64. Cai, S., **Cai, C.**, and Li, J., Weakly Charged Round Micro-Plasma Jet Flows Into Vacuum, *Physics of Plasma*, Vol.26, 052109, May, 2019.
- j63. Cai, S., **Cai, C.**, and Li, J., New Approach to Estimate Total Jet Loads On Spacecrafts With Different Knudsen Numbers, *AIAA Journal*, Vol.57, No.4, May 2019, <https://doi.org/10.2514/1.J058170>.
- j62. Cai, S., **Cai, C.**, and Li, J., Jet Loads At Different Knudsen Numbers, *Physics of Fluids*, Vol.30, 127101, Dec. 2018. doi:10.1063/1.5064710.
- j61. Zhang, K., **Cai, C.**, and Cooke, D., Simple Relations for Electron Temperature and Potential in Dilute Cold Plasma Flows, *Journal of Plasma Physics*, Vol.25, 012128, 2018. <https://doi.org/10.1063/1.5010768>.
- j60. Cai, S., **Cai, C.**, Zhang, K., and Li, J., Rarefaction Effects on Jet Impingement Loads, *Aerospace*, 2018, Vol.4, 48, doi:10.3390/AEROSPACE4030048.
- j59. **Cai, C.**, An Improved Electron Pre-Sheath Model for TSS-1R Current Enhancement Computation, *Aerospace*, 2017, Vol.4, No.16. doi:10.3390/aerospace4010016.
- j58. He, X., and **Cai, C.**, Boundary Condition Effects on Velocity and Thermal Compressible Boundary Layer Flows Over A Flat Plate. *Brazilian Journal of Physics*, Vol.47, No.2, Feb. 2017, pp.182-188. doi:10.1007/s13538-017-0488-x.
- j57. **Cai, C.**, A New Gaskinetic Model To Analyze Background Flow Effects On Weak Gaseous Jet Flows From Electric Propulsion Devices, *Aerospace*, Vol.4, No.5, 2017, doi:10.3390/aerospace401005.
- j56. **Cai, C.**, He, X., and Zhang, K., Comprehensive Studies on Rarefied Jet and Jet Impingement Flows with Gaskinetic Methods, *Communications in Computational Physics*, Vol.23, No.3, pp.712-741, Sept.2017.
- j55. **Cai, C.**, and Cooke, D., A Simple Model for Electron Temperature In Dilute Plasma Flows, *Physics of Plasmas*, Vol.23, 103513, 2016. doi:http://dx.doi.org/10.1063/1.4965229.
- j54. **Cai, C.**, and He, X., Comprehensive Investigations of High Knudsen Number Planar Jet Impingement on An Inclined Flat Plate, *Physics of Fluids*, Vol.28, 056103, 2016.
- j53. **Cai, C.**, Numerical Simulations of High Enthalpy Flows Around Entry Bodies, *Chinese Journal of Aeronautics*, No.2, April, 2016.
- j52. **Cai, C.**, New Continuum Stagnation Point Flow, *AIAA Journal*, Vol.53, No. 11, pp.3496-3499, 2015, doi: 10.2514/1.J053926.
- j51. **Cai, C.**, Highly Dilute Gas Flow Field around a Cylinder and Sphere, *Journal of Spacecraft and Rockets*, Vol 52, No.5, pp.1495-1502, Sept. 2015.
- j50. Rodriguez, G., and **Cai, C.**, Near Continuum Rotating Plate Flows. *Brazilian Journal of Physics*, Vol.45, No.4, pp.431-438, June, 2015, doi:10.1007/S13538-05-0333-z.
- j49. **Cai, C.**, Near Continuum Gas Flows over a Cylinder, *Journal of Thermophysics and Heat*

*Transfer*, Vol.30, No.1., pp.25-31, 2016, doi:10.2514/1.T4616.

j48. **Cai, C.**, Near Continuum Boundary Layer Flows over a Flat Plate, *Theoretical and Applied Mechanics Letter*, Vol. 5, 2015, pp.134-139. doi:10.1016/j.taml.2015.03.005.

j47. Khaleel, K., **Cai, C.**, Mohammad, T., Comprehensive Analytical Study of Rarefied Jet Flow of Annular Exit Impingement at Vertical Flat Plate, *International Journal of Fluid Mechanics Research*, Vol.42, No.5, pp.404-417, 2015.

j46. **Cai, C.**, and Sun, Q., Near Continuum Gas Flow Over a Sphere, *Computers & Fluids*, Vol.111, pp.62-68, April 2015. doi:10.1016/j.compfluid.2015.01.004.

j45. **Cai, C.**, Numerical Investigations on Plasma Plume Flows from a Cluster of Electric Propulsion Devices, *Aerospace Science & Technology*, Vol.41, pp.134-143. doi:10.1016/j.ast.2014.12.018.

j44. **Cai, C.**, Rocket Plume Modeling, *AIAA Journal*, Vol.52, No.12, pp.2907-1910, December 2014.

j43. Sun, Q., **Cai, C.**, and Gao, W., On the Validity of the Boltzmann-BGK Model Through Relaxation Evaluation, *Acta Mechanica Sinica*, Vol.30, No.2, pp.133-142, Jan. 2014, doi:10.1007/s10409-014-0017-x.

j42. **Cai, C.**, Stagnation Point Properties for Non-Continuum Gaseous Jet Impinging At A Flat Plate Surface From A Planar Exit, Vol.25, No.10, 106103, *Physics of Fluids*, Oct. 2013. Doi:10.1063/1.4825172.

j41. **Cai, C.**, and Wang, L., Gaskinetic Analytical and Numerical Studies on Rarefied Unsteady Planar Jet Flows, *Physica Scripta*, Vol.88, No.4, 045501, Oct. 2013.

j40. **Cai, C.**, Sun, Q., and VanderWyst, A., Exact Analytical Solutions to Unsteady Collisionless Plume Flows into a Vacuum, *Acta Astronautica*, Vol.91, pp.218-227, 2013.

j39. **Cai, C.**, and Khasawneh, K., Approximate Solutions for Rarefied Gas Flows Inside an Enclosure, *Theoretical and Applied Physics Letters*, May, 2013.

j38. Wang L. and **Cai, C.**, High Speed and High Knudsen Number Jets into a Vacuum, *Chinese Journal of Aeronautics*, May, 2013.

j37. Wang, L., and **Cai, C.**, Gaseous Plume Flows in Space Propulsion, *Chinese Journal of Aeronautics*, Vol.26, No.3, pp.522-528, May, 2013.

j36. **Cai, C.**, and Zou, C., Gaskinetic Solutions on High Knudsen Planar Jet Impingement Flows, *Communications in Computational Physics*, Vol.14, No.4, pp.960-978, Oct. 2013.

j35. **Cai, C.** and Zou, C., A Gaskinetic Study on Planar Collisionless Jet Impingement at a Specular Reflective Plate, *Theoretical and Applied Physics Letters*, Vol.3, 02004, March, 2012, doi:10.1063/2.120xy0z.

j34. Khasawneh, K., and **Cai, C.**, Higher Order Slip Boundary Solutions for Gaseous Flow in a Uniform Rectangular Micro-channel, *Journal of Fluids and Thermal Sciences*, Vol.1, No.1, 11 April 2012, pp.71-83.

j33. **Cai, C.**, and Huang, X., High Speed Rarefied Round Jet Impingement Flows, *AIAA Journal*, Vol.50, No.12, pp.2908-2911, Dec., 2012.

j32. **Cai, C.**, and Wang, L., High Speed Effusion Flow from a Rectangular Exit into Vacuum, *Vacuum*, Vol.86, No.20, Dec., 2012. <http://dx.doi.org/10.1016/j.vacuum.2012.09.009>.

j31. **Cai, C.**, and Wang, L., Numerical Validations For A Set of Complete Gaskinetic Rocket Plume Solutions, *Journal of Spacecraft and Rockets*, Vol.49, No.1, 2012, pp.59-68, Feb.2012. doi:10.2514

/1.A32046.

- j30. Liu, H., **Cai, C.**, and Zou, C., An Object-Oriented Implementation of the DSMC Method, *Computer & Fluids*, Vol.57, pp.65-75, March 2012. doi: 10.1016/j.compfluid.2011.12.007.
- j29. **Cai, C.** and Wang, L., Rarefied Planar Jets into Vacuum, *Theoretical and Applied Physics Letters*, 2, 012004, Jan., 2012.
- j28. Luo H., Xia Y., Li S., Nourgaliev R., and **Cai, C.**, A Hermite WENO Reconstruction-based Discontinuous Galerkin Method for the Euler Equations on Tetrahedral Grids, *Journal of Computational Physics*, Vol.23, No.16, pp.5489-5503, June 2012.
- j27. Khasawneh, K.R., Liu, H., and **Cai, C.**, Surface Properties for Rarefied Circular Jet Plume Impingement on a Flat Plate, *Physics of Fluids*, Vol.23, No.2, 027102, Feb. 2011. doi:10.1063/1.3549934.
- j26. Luo, H., Luo, L., Ali, A., Nourgaliev, R., and **Cai, C.**, A Parallel, Reconstructed Discontinuous Galerkin Method for the Compressible Flows on Arbitrary Grids, *Communications in Computational Physics (CiCp)*, Vol.9, No.2, 2010, pp.363-389.
- j25. Khasawneh, K.R., Liu, H., and **Cai, C.**, Highly Rarefied Two-Dimensional Jet Plume Impingement on a Flat Plate, *Physics of Fluids*, Vol.22, No.11, 117101. Nov.2010. doi:10.1063/1.3490409.
- j24. Tang, H., Xu, K., and **Cai, C.**, Gas-kinetic scheme for three dimensional magneto-hydrodynamics, *Numerical Mathematics: Theory, Methods and Applications*, Vol.3, No.4, pp.387-404, Nov. 2010.
- j23. **Cai, C.**, Khasawneh, K., Liu, H. and Wei, M., Collisionless Gas Flows over a Cylindrical or a Spherical Object, *Journal of Spacecraft and Rockets*, Vol.46, No.6, pp.1124, Nov. 2009.
- j22. **Cai, C.**, and Khasawneh, K., Collisionless Gas Flow over a Cryogenic Flat Plate, *Journal of Vacuum Sciences and Technology (A)*, Vol.27, No.4, pp.601-610, June 2009.
- j21. **Cai, C.**, and Liu, D. D., Asymptotic Solutions for Low Magnetic Reynolds Number Gas Flows inside a Two-Dimensional Channel, *AIAA Journal*, Vol.47, No.3, pp.542-551, March 2009.
- j20. Xu, K., He, X., and **Cai, C.**, Multiple Temperature Gaskinetic Model and Multi-scale Gaskinetic Method for Nonequilibrium Rarefied Flow Computation, *Journal of Computational Physics*, Vol.227, No.14, pp.6779-6794, July 2008.
- j19. **Cai, C.**, and Liu, D. D., Collisionless Gas Flows I: Inside Arbitrary Enclosures, *Physics of Fluids*, Vol. 20, No.6, 067105, 2008.
- j18. **Cai, C.**, Liu, D. D. and Xu, K., One-Dimensional Multi-Temperature Gaskinetic BGK Scheme for Planar Shock Wave Computations, *AIAA Journal*, Vol.46, No.5, pp.1054-1062, May 2008.
- j17. **Cai, C.**, Heat Transfer in Vacuum Packaged MEMS Devices, *Physics of Fluids*, Vol.20, No.1, 017103, 2008.
- j16. **Cai, C.**, and Boyd, I. D., Collisionless Gas Flow Expanding into Vacuum, *Journal of Spacecraft and Rockets*, Vol.44, No.6, pp.1326-1330, November-December 2007.
- j15. **Cai, C.**, Sun, Q. and Boyd, I. D., Gas Flows in Micro-channels and Micro-tubes, *Journal of Fluid Mechanics*, Vol.589, pp.305-314, Oct.2007.
- j14. **Cai, C.**, and He, X., Energy Deposition/Extraction Effects on Oblique Shock Waves Over a Wedge, *AIAA Journal*, Vol.45, No.9, pp.2267-2272, September 2007.
- j13. **Cai, C.**, and Boyd, I. D., Compressible Gas Flows in a Two-Dimensional Planar Microchannel, *Journal of Thermophysics and Heat Transfer*, Vol.21, No.3, pp.608-615, 2007.

- j12. **Cai, C.**, and Boyd, I. D., Theoretical and Numerical Study of Several Free Molecular Flow Problems, *Journal of Spacecraft and Rockets*, Vol.44, No.3, May-June 2007, pp.619-624.
- j11. **Cai, C.**, Energy Deposition/Absorption Effects on a Planar Shock Wave, *Journal of Thermophysics and Heat Transfer*, Vol.21, No.1, January-March, 2007, pp.252-254.
- j10. **Cai, C.**, Boyd I. D., and Sun, Q., Background Free Molecular Flows Between Two Plates with Pumps, *Journal of Thermophysics and Heat Transfer*, Vol.21, No.1, January-March, 2007, pp.94-104.
- j9. **Cai, C.**, Boyd I. D., and Sun, Q., Rarefied Background Flow in a Vacuum Chamber Equipped with One-Sided Pumps, *Journal of Thermophysics and Heat Transfer*, Vol.20, No.3, 2006, pp.524-535.
- j8. **Cai, C.**, Boyd I. D., and Sun, Q., Free Molecular Background Flow in a Vacuum Chamber Equipped with Two-Sided Pumps, *Journal of Vacuum and Science Technology (A)*, Vol.24, No.1, Jan. 2006, pp.9-19.
- j7. Sun, Q., **Cai, C.**, and Boyd I. D., Computational Analysis of High-Altitude Ionization Gauge Flight Measurements, *Journal of Spacecraft and Rockets*, Vol.43, No.1, Jan. 2006, pp.186-193.
- j6. Walker, M. L., Gallimore, A. D., Boyd, I. D., and **Cai, C.**, Vacuum Chamber Pressure Maps of a Hall Thruster Cold-Flow Expansion, *Journal of Propulsion and Power*, Vol.20, No.6, Nov. 2004, pp.1127-1131.
- j5. Fan, J., Boyd, I. D., **Cai, C.**, Hennighausen, K., and Candler, G. V., Computation of Rarefied Gas Flows around a NACA 0012 Airfoil, *AIAA Journal*, Vol.39, No.4, April 2001, pp.618-625.
- j4. Stefanov, S., Boyd, I. D., and **Cai, C.**, Monte Carlo Analysis of Macroscopic Fluctuations in a Rarefied Hypersonic Flow around a Cylinder, *Physics of Fluids*, Vol.12, No.5, 2000, pp.1226-1239.
- j3. **Cai, C.**, Boyd I. D., Fan, J., and Candler, G. V., Direct Simulation Methods for Low-Speed Microchannel Flows, *Journal of Thermophysics and Heat Transfer*, Vol. 14, No.3, July-September 2000, pp.368-378.
- j2. Yao, W., **Cai, C.**, Zhao, L., Wang, F., and Wang, G., Stability Analysis and Transition Prediction of a Compressible Boundary Layer, *Chinese Journal of Computational Physics*, No.3, 1999.
- j1. Wang, F., **Cai, C.** and Zhao, L., An Iterative Method for Compressible Flow Transition Predictions, *Acta Aerodynamic Sinica*, Vol.16, No.4, 1998, pp.485-491.