

## **Sarma L. Rani**

Associate Professor

Department of Mechanical and Aerospace Engineering

University of Alabama in Huntsville

Huntsville, AL 35899

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### **EDUCATION**

**Post-Doctoral Associate**, Mechanical and Aerospace Engineering, Cornell University, Ithaca, 2003-2004

*Research Topic:* DNS and theoretical study of the relative motion of inertial particles in isotropic turbulence and its application to droplet motion in cumulus clouds

*Advisor:* Prof. Lance R. Collins

**Ph.D.**, Mechanical Engineering, University of Illinois at Urbana-Champaign, 2002

*Thesis Title:* Direct Numerical Simulations of Two-Way Coupling Effects in a Particle-Laden Turbulent Pipe Flow & Evaluation of the Equilibrium Eulerian Approach for the Evolution of Particle Concentration in Isotropic Turbulence

*Advisors:* Prof. S. Pratap Vanka (currently an Emeritus Professor at UIUC) & Prof. S. Balachandar (currently at the University of Florida, Gainesville)

**M.S.**, Mechanical Engineering, Texas A&M University, College Station, 1998

*Thesis Title:* Quantitative Flow Visualization by Hydraulic Analogy

*Advisor:* Prof. Margaret S. Wooldridge (currently at the University of Michigan, Ann Arbor)

**B.Engr.**, Mechanical Engineering, Birla Institute of Technology and Science, Pilani, India, 1996  
(Graduated with Distinction)

### **RESEARCH AREAS**

Research in our group focuses on computational and theoretical investigations in three main areas: (1) Dynamics of disperse spherical and complex-shaped particles in turbulent flows, (2) Linear and non-linear combustion instability analysis, and acoustic wave propagation in inhomogeneous media, and (3) development of low-dissipation, high-order shock-capturing numerical schemes for laminar/turbulent compressible flows, as well as numerical schemes for the solution of low- to high-Mach number flows.

In the area of particle-laden turbulent flows, we perform direct numerical simulations (DNS), as well as develop stochastic theories for studying the relative motion of inertial particles in turbulence. To predict combustion instabilities in premixed combustion systems, novel linear modal analysis techniques and flame response functions have been developed. Non-linear and limit cycle analysis of combustion instabilities through analytically rigorous theory and computations are being undertaken. Improved WKB-based solutions methods for the acoustic wave equation in inhomogeneous media are being derived. Low dissipation, high order shock-capturing schemes are also being developed for compressible flows with shocks. Numerical methods are being developed that can accurately simulate laminar/turbulent compressible flows with shocks, as well as flows that span a broad range of Mach numbers. Novel and improved implicit Roe-based numerical schemes for hyperbolic governing equations are under development.

### **AWARDS AND HONORS**

- Graduate School Outstanding Advisor, University of Alabama in Huntsville (UAH), 2020
- College of Engineering Outstanding Professor Award, UAH, 2017
- College of Engineering Outstanding Junior Professor Award, UAH, 2016
- UAH Individual Investigator Distinguished Research Grant, 2017

- UAH Individual Investigator Distinguished Research Grant, 2015
- UAH Individual Investigator Distinguished Research Grant, 2013
- NASA Research Infrastructure Development Seed Grant, 2016
- NASA Research Infrastructure Development Seed Grant, 2012

## ACADEMIC AND PROFESSIONAL EXPERIENCE

- |                                                                                                                             |                       |
|-----------------------------------------------------------------------------------------------------------------------------|-----------------------|
| • Associate Professor, Dept. of Mechanical and Aerospace Engineering, University of Alabama in Huntsville                   | August 2017-Present   |
| • Assistant Professor, Dept. of Mechanical and Aerospace Engineering, University of Alabama in Huntsville                   | August 2011-July 2017 |
| • Part-Time Lecturer, University of Alabama in Huntsville                                                                   | 2009-2011             |
| • Principal Research Engineer, Combustion Group, CFD Research Corporation (CFDRC), Huntsville, AL                           | July 2008-July 2011   |
| • Senior Research Engineer, Combustion Group, CFDRC                                                                         | Jan. 2007-June 2008   |
| • Research Engineer, Combustion Group, CFDRC                                                                                | April 2005-Dec. 2006  |
| • Associate, Continuum Dynamics, Inc.                                                                                       | Oct. 2004-March 2005  |
| • Post-Doctoral Associate, Sibley School of Mechanical and Aerospace Engineering, Cornell University                        | 2003-2004             |
| • Graduate Research Assistant, Mechanical and Industrial Engineering Department, University of Illinois at Urbana-Champaign | 1998-2002             |
| • Graduate Teaching Assistant, Mechanical Engineering Department, Texas A&M University, College Station                     | 1996-1998             |

## PUBLICATIONS

### Journal Articles

1. Sarma L. Rani, and M. S. Wooldridge, "Quantitative flow visualization using the hydraulic analogy," *Experiments in Fluids*, Vol. 28, pp. 165-169, 2000. <https://doi.org/10.1007/s003480050021>
2. Sarma L. Rani, and S. Balachandar, "Evaluation of the equilibrium Eulerian approach for the evolution of particle concentration in isotropic turbulence," *International Journal of Multiphase Flow*, Vol. 29(12), pp. 1793-1816, 2003. <https://doi.org/10.1016/j.ijmultiphaseflow.2003.09.005>
3. Jim Ferry, Sarma L. Rani, and S. Balachandar, "A locally implicit improvement of the equilibrium Eulerian method," *International Journal of Multiphase Flow*, Vol. 29(6), pp. 869-891, 2003. [https://doi.org/10.1016/S0301-9322\(03\)00064-8](https://doi.org/10.1016/S0301-9322(03)00064-8)
4. Sarma L. Rani, and S. Balachandar, "Preferential concentration of particles in isotropic turbulence: A comparison of the Lagrangian and the equilibrium Eulerian approaches," *Powder Technology journal*, Vol. 141, pp. 109-118, 2004. <https://doi.org/10.1016/j.powtec.2004.02.016>
5. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "Numerical simulations of turbulence modulation by dense particles in a fully developed pipe flow," *Powder Technology journal*, Vol. 141, pp. 80-99, 2004. <https://doi.org/10.1016/j.powtec.2004.02.012>
6. D. L. Cottrell, Sarma L. Rani, and A. J. Pearlstein, "Computational assessment of subcritical instability and apparent transition delay in spiral Poiseuille flow experiments," *Journal of Fluid Mechanics*, Vol. 509, pp. 353-378, 2004. <https://doi.org/10.1017/S0022112004008845>

7. C. M. Winkler, Sarma L. Rani, and S. P. Vanka, "Preferential concentration of particles in a fully developed turbulent square duct flow," *International Journal of Multiphase Flow*, Vol. 30(1), pp. 27-50, 2004. <https://doi.org/10.1016/j.ijmultiphaseflow.2003.11.003>
8. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "A new algorithm for computing binary collisions in dispersed two-phase flows," *Numerical Heat Transfer: Part B: Fundamentals*, Vol. 45(1), pp. 99-107, 2004. <https://doi.org/10.1080/1040779049025382>
9. J. Chun, D. L. Koch, Sarma L. Rani, A. Ahluwalia, and L. R. Collins, "Clustering of aerosol particles in isotropic turbulence," *Journal of Fluid Mechanics*, Vol. 536, pp. 219-251, 2005. <https://doi.org/10.1017/S0022112005004568>
10. C. M. Winkler, Sarma L. Rani, and S. P. Vanka, "Evaluation of subgrid scale kinetic energy models in large eddy simulations of turbulent channel flow," *International Journal of Numerical Methods for Heat and Fluid Flow*, Vol. 16, No. 2, pp. 226-239, 2006. <https://doi.org/10.1108/09615530610644280>
11. C. M. Winkler, Sarma L. Rani, and S. P. Vanka, "A numerical study of particle wall-deposition in a turbulent square duct flow," *Powder Technology*, Vol. 170(1), pp. 12-25, 2006. <https://doi.org/10.1016/j.powtec.2006.08.009>
12. J. F. Horn, D. O. Bridges, D. A. Wachspress, and Sarma L. Rani, "Implementation of a Free-Vortex Wake Model in Real-Time Simulation of Rotorcraft," *Journal of Aerospace Computing, Information, and Communication*, Vol. 3, pp. 93-114, 2006. <https://doi.org/10.2514/1.18273>
13. Sarma L. Rani, Clifford E. Smith, and Andrew C. Nix, "Boundary Layer Equation-Based Wall Modeling for Large Eddy Simulation of Turbulent Flows with Wall Heat Transfer," *Numerical Heat Transfer: Part B*, Vol. 55(2), pp. 91-115, 2009. <https://doi.org/10.1080/10407790802605281>
14. C. M. Winkler, and Sarma L. Rani, "Relative Importance of the Lift Force on Heavy Particles Due to Turbulence Driven Secondary Flows," *Powder Technology*, Vol. 190(3), pp. 310-318, 2009. <https://doi.org/10.1016/j.powtec.2008.08.015>
15. Sarma L. Rani, "Reduced Order Model for Combustion Instability in a Two-Dimensional Duct with a Flameholder," *AIAA Journal of Propulsion and Power*, Vol. 25(1), pp. 237-248, 2009. <https://doi.org/10.2514/1.35958>
16. Sarma L. Rani, "Computationally efficient stochastic simulations of high stokes number particles in isotropic turbulence," *Powder Technology journal*, Vol. 250, pp. 67-74, 2013. <https://doi.org/10.1016/j.powtec.2013.10.004>
17. S. Bidadi, and Sarma L. Rani, "Quantification of numerical diffusivity due to TVD schemes in the advection equation," *Journal of Computational Physics*, Vol. 261, pp. 65-82, 2014. <https://doi.org/10.1016/j.jcp.2013.12.011>
18. Sarma L. Rani, R. Dhariwal, and D. L. Koch, "A Stochastic Model for the Relative Motion of High Stokes Number Particle Pairs in Isotropic Turbulence", *Journal of Fluid Mechanics*, Vol. 756, pp. 870-902, 2014. <https://doi.org/10.1017/jfm.2014.461>
19. V. K. Rani and Sarma L. Rani, "Acoustically Consistent Investigation of Combustion Instabilities in a Dump Combustor," *Journal of Propulsion and Power*, Vol. 31(1), pp. 294-308, 2015. <https://doi.org/10.2514/1.B35296>
20. S. Bidadi, and Sarma L. Rani, "Investigation of numerical viscosities and dissipation rates of second-order TVD-MUSCL schemes for implicit large-eddy simulation," *Journal of Computational Physics*, Vol. 281, pp. 1003-1031, 2015. <https://doi.org/10.1016/j.jcp.2014.10.057>
21. J. W. Bennewitz, Sarma L. Rani, J. T. Cranford, and R. A. Frederick, "Combustion Instability Control through Acoustic Modulation at the Inlet Boundary: Analysis," *AIAA Journal of Propulsion and Power*, Vol. 31(6), pp. 1689-1695, 2015. <https://doi.org/10.2514/1.B35650>

22. S. Bidadi, and Sarma L. Rani, "On the stability and diffusive characteristics of Roe-MUSCL and Runge-Kutta schemes for inviscid Taylor-Green vortex," *Journal of Computational Physics*, Vol. 299, pp. 339-351, 2015. <https://doi.org/10.1016/j.jcp.2015.07.013>
23. B. R. Girgis, Sarma L. Rani, and A. Frendi, "Flowfield Dependent Variation Method: A Numerical Scheme for the Solution of Low- to High-Mach Number Flow Problems," *International Journal of Numerical Methods in Heat and Fluid Flow*, Vol. 26, No. 5, pp. 1486-1525, 2016. <https://doi.org/10.1108/HFF-04-2015-0137>
24. S. F. Olatoyinbo, Sarma L. Rani, and A. Frendi, "Large-Eddy Simulation of Decaying Isotropic Turbulence using the Flowfield Dependent Variation Method," *International Journal of Numerical Methods in Heat and Fluid Flow*, Vol. 27, No. 1, pp. 235-262, 2017. <https://doi.org/10.1108/HFF-07-2015-0290>
25. R. Dhariwal, Sarma L. Rani, and D. L. Koch, "Stochastic Theory and Direct Numerical Simulations of the Relative Motion of High-Inertia Particle Pairs in Isotropic Turbulence," *Journal of Fluid Mechanics*, Vol. 813, pp. 205-249, 2017. <https://doi.org/10.1017/jfm.2016.859>
26. V. K. Rani, and Sarma L. Rani, "Development of a comprehensive flame transfer function and its application to predict combustion instabilities in a dump combustor," *Combustion Science and Technology journal*, Vol. 190, No. 8, pp. 1313-1353, 2018. <https://doi.org/10.1080/00102202.2018.1440215>
27. V. K. Rani, and Sarma L. Rani, "WKB solutions to the quasi 1-D acoustic wave equation in ducts with non-uniform cross-section and inhomogeneous mean flow properties Part I. Acoustic Field," *Journal of Sound and Vibration*, Vol. 436, pp. 183-201, 2018. <https://doi.org/10.1016/j.jsv.2018.06.065>
28. V. K. Rani, and Sarma L. Rani, "WKB solutions to the quasi 1-D acoustic wave equation in ducts with non-uniform cross-section and inhomogeneous mean flow properties Part II. Combustion Instabilities," *Journal of Sound and Vibration*, Vol. 436, pp. 201-219, 2018. <https://doi.org/10.1016/j.jsv.2018.06.065>
29. R. Dhariwal, and Sarma L. Rani, "Effects of deterministic and stochastic forcing schemes on the relative motion of inertial particles in DNS of isotropic turbulence," *Powder Technology journal*, Vol. 339, pp. 46-69, 2018. <https://doi.org/10.1016/j.powtec.2018.07.058>
30. Sarma L. Rani, V. K. Gupta, and Donald L. Koch "Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence. I. Drift and Diffusion Flux closures," *Journal of Fluid Mechanics*, Vol. 871, pp. 450-476, 2019. <https://doi.org/10.1017/jfm.2019.204>
31. Sarma L. Rani, R. Dhariwal, and Donald L. Koch "Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence. II. Comparison of Theory and DNS," *Journal of Fluid Mechanics*, Vol. 871, pp. 477-488, 2019. <https://doi.org/10.1017/jfm.2019.294>

### **Journal Manuscripts Under Preparation**

1. Sarma L. Rani, R. Dhariwal and D. L. Koch "Forcing in DNS of Isotropic Turbulence and its Effects on Closure Model for the Diffusion Current of High-Inertia Particle Pairs," *Journal of Fluid Mechanics*.
2. Annette Fisher and Sarma L. Rani, "A Narrow Band Model Based on the Absorption Coefficient and its Application to the Calculation of Radiative Transfer in One-Dimensional Enclosures, *Journal of Quantitative Spectroscopy and Radiative Transfer*.
3. Annette Fisher and Sarma L. Rani, "A Narrow Band Model Based on the Absorption Coefficient and its Application to the Calculation of Radiative Transfer in Two-Dimensional Enclosures, *Journal of Quantitative Spectroscopy and Radiative Transfer*.
4. Sattik Basu and Sarma L. Rani, "On the Neumann Boundary Condition for the Acoustic-Wave Helmholtz Equation, and the Relationship between Pressure and Density Fluctuations," *Journal of Sound and Vibration*.
5. Sattik Basu and Sarma L. Rani, "Improved WKB Solutions to the Acoustic Wave Equation in Inhomogeneous Media," *Journal of Sound and Vibration*.

6. Hayden Arceneaux and Sarma L. Rani, "High Order Central Differencing about a Cell Face using the Roe Scheme with Higher Order Reconstruction," *Journal of Computational Physics*.

### **Refereed Conference Proceedings**

1. Sarma L. Rani, and M. S. Wooldridge, "Quantitative supersonic flow visualization by the hydraulic analogy," ASME International Mechanical Engineering Congress and Exposition 1997, Dallas, TX.
2. Sarma L. Rani, and S. P. Vanka, "DNS of two-way coupling effects in a fully-developed turbulent pipe flow," ASME Fluids Engineering Division Summer Conference, June 11-15, 2000, Boston, MA.
3. Sarma L. Rani, and S. P. Vanka, "LES and DNS of turbulence modification by dispersed solid particles in a fully developed pipe flow," The 36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 16-19 2000, Huntsville, AL.
4. J. Ferry, S. Balachandar, and Sarma L. Rani, "A locally implicit improvement of the equilibrium Eulerian method," ASME Fluids Engineering Division Summer Conference 2002, Montreal, Canada.
5. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "Large eddy simulations of particle dispersion by turbulence driven secondary flows in a square duct," The 6th ASME-JSME Thermal Engineering Joint Conference, March 16-20 2003, Kohala Coast, Hawaii.
6. J. F. Horn, D. O. Bridges, D. A. Wachspress and Sarma L. Rani, "Implementation of a Free-Vortex Wake Model in Real-Time Simulation of Rotorcraft," Proceedings of the 61st Annual Forum of the American Helicopter Society, 2005, Grapevine, TX.
7. Sarma L. Rani, C. E. Smith, S. Hemchandra, T. C. Lieuwen, B. Sekar, "Reduced-Order Stability Analysis Model for Predicting Dynamic Instabilities in Bluffbody Flameholder Geometries," 43rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference Proceedings, AIAA Paper No. 2007-5649.
8. Sarma L. Rani and Edward A. Luke, "Advanced Non-Gray Radiation Module in the Loci Framework for Combustion CFD," 44th AIAA/ASME/SAE/ASEE Joint Propulsion Conference Proceedings, AIAA Paper No. 2008-5253.
9. H. Q. Yang, A. Przekwas, Sarma L. Rani, and J. Dudley, "Direct Numerical Simulation Validation Study of a Fully Coupled Fluid-Structure Interaction Tool," 51st AIAA Aerospace Sciences Meeting 2013, AIAA Paper No. 2013-0095, Grapevine, TX.
10. V. Rani and Sarma L. Rani, "An Acoustically Consistent Investigation of Combustion Instabilities in a Dump Combustor," 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 2014, Cincinnati, AIAA Paper No. 2014-3779.
11. J. T. Cranford, J. W. Bennewitz, Sarma L. Rani, and R. A. Frederick, "An Analytical Investigation Characterizing the Application of Single Frequency Acoustic Modulation for High Frequency Combustion Instability Suppression," 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 2014, Cincinnati, OH, AIAA Paper No. 2014-3679.
12. V. Rani and Sarma L. Rani, "Development and Analysis of a Novel Two-Dimensional Flame Response Function," 51st AIAA/SAE/ASEE Joint Propulsion Conference, 2015, Orlando, FL, AIAA Paper No. 2015-4164.
13. A. S. Fisher and Sarma L. Rani, "Comparison of Wide Band, Narrow Band, and SLW Models with HITRAN and HITEMP for Predicting Radiative Heat Transfer," 47th AIAA Thermophysics Conference, AIAA Aviation Forum, Denver, CO, AIAA Paper No. 2017-4537.
14. V. Rani and Sarma L. Rani, "Development of a Novel Approximate Solution to the Acoustic Wave Equation with Mean Gradients and its Application to Predicting Combustion Instabilities in a Dump Combustor," 53rd AIAA/SAE/ASEE Joint Propulsion Conference, 2017, Atlanta, GA, AIAA Paper No. 2017-4688.

## Non-Refereed Conference Presentations

1. Sarma L. Rani, and S. P. Vanka, "Large eddy simulation of turbulence modification and particle dispersion in a fully developed pipe flow," American Physical Society 52nd Annual Meeting of the Division of Fluid Dynamics, Nov. 21-23 1999, New Orleans.
2. D. L. Cotrell, Sarma L. Rani, and A. J. Pearlstein, "The complete linear stability boundary for spiral Poiseuille flow," American Physical Society 53rd Annual Meeting of the Division of Fluid Dynamics, Nov. 19-21 2000, Washington D.C.
3. D. L. Cotrell, Sarma L. Rani, and A. J. Pearlstein, "The complete linear stability boundary for spiral Poiseuille flow," The 12th International Taylor-Couette Flow Workshop, Sep. 6-8 2001, Evanston, Illinois.
4. Sarma L. Rani, and S. P. Vanka, "Two-way coupling effects in a particle-laden turbulent pipe flow," American Physical Society 54th Annual Meeting of the Division of Fluid Dynamics, Nov. 18-20 2001, San Diego.
5. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "Preferential concentration of particles in a fully developed turbulent square duct flow," American Physical Society 55th Annual Meeting of the Division of Fluid Dynamics, Nov. 24-26 2002, Dallas.
6. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "Large eddy simulations of particle deposition in a fully developed turbulent square duct flow," American Physical Society 55th Annual Meeting of the Division of Fluid Dynamics, Nov. 24-26 2002, Dallas.
7. Sarma L. Rani, C. M. Winkler, and S. P. Vanka, "Large eddy simulations of particle deposition in a turbulent square duct flow," The Third International Symposium on Turbulence and Shear Flow Phenomena, June 24-27 2003, Sendai, Japan.
8. Sarma L. Rani, and C. M. Winkler, "Forces on particles in a turbulent square duct flow," American Physical Society 56th Annual Meeting of the Division of Fluid Dynamics, Nov. 23-25 2003, NJ.
9. Sarma L. Rani, and Donald L. Koch, "On Pair Diffusion and Preferential Concentration of High Stokes Number Particles in Isotropic Turbulence," American Physical Society 65th Annual Meeting of the Division of Fluid Dynamics, Nov. 18-20, 2012, San Diego.
10. Sarma L. Rani, "A Stochastic Model for High Stokes Number Particle Pair Dynamics in Isotropic Turbulence," ASME-AMD Summer Meeting, Society of Engineering Science 50th Annual Technical Meeting, Brown University, July 28-31, 2013, Providence.
11. Rohit Dhariwal, Sarma L. Rani, and Donald L. Koch, "A Stochastic Model for the Relative Motion of High Stokes Number Particles in Isotropic Turbulence," American Physical Society 67th Annual Meeting of the Division of Fluid Dynamics, Nov. 23-25, 2014, San Francisco.
12. Vijaya Krishna Rani, and Sarma L. Rani, "An Acoustically Consistent Investigation of Combustion Instabilities in a Dump Combustor," American Physical Society 67th Annual Meeting of the Division of Fluid Dynamics, Nov. 23-25, 2014, San Francisco.
13. Rohit Dhariwal, Sarma L. Rani, and Donald L. Koch, "Analysis and Comparison with DNS of a Stochastic Model for the Relative Motion of High-Stokes-Number Particles in Isotropic Turbulence," American Physical Society 68th Annual Meeting of the Division of Fluid Dynamics, Nov. 22-24, 2015, Boston, MA.
14. Vijaya Krishna Rani, and Sarma L. Rani, "Analysis of Premixed Flame Response and Rayleigh Criterion through a Novel Flame Transfer Function," American Physical Society 68th Annual Meeting of the Division of Fluid Dynamics, Nov. 22-24, 2015, Boston, MA.
15. Shreyas Bidadi, and Sarma L. Rani, "On the Stability and Diffusive Characteristics of Roe-MUSCL and Runge-Kutta Schemes for Implicit LES," Spring Southeastern Sectional Meeting of American Mathematical Society, March 27-29, 2015, Huntsville, AL.

16. Rohit Dhariwal, Kiruthika Sundararajan, and Sarma L. Rani, "Effects of Deterministic and Stochastic Forcing Schemes on Inertial Particle Statistics in DNS of Isotropic Turbulence," American Physical Society 69th Annual Meeting of the Division of Fluid Dynamics, Nov. 20-22, 2016, Portland, OR.
17. Sarma L. Rani, Rohit Dhariwal, and Donald L. Koch, "Comparison of Stochastic Theory and DNS for the Relative Motion of High-Inertia Particle Pairs in Isotropic Turbulence," American Physical Society 69th Annual Meeting of the Division of Fluid Dynamics, Nov. 20-22, 2016, Portland, OR.
18. Sarma L. Rani, V. K. Gupta, and Donald L. Koch, "Stochastic Model and DNS for the Clustering of Rapidly Settling, Low-Inertia Monodisperse Pairs in Isotropic Turbulence-I," American Physical Society 70th Annual Meeting of the Division of Fluid Dynamics, Nov. 19-21, 2017, Denver, CO.
19. Sarma L. Rani, V. K. Gupta, and Donald L. Koch, "Stochastic Model and DNS for the Clustering of Rapidly Settling, Low-Inertia Monodisperse Pairs in Isotropic Turbulence-II," American Physical Society 70th Annual Meeting of the Division of Fluid Dynamics, Nov. 19-21, 2017, Denver, CO.
20. Sarma L. Rani and Donald L. Koch, "Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence. I. Drift and Diffusion Flux Closures," American Physical Society 71st Annual Meeting of the Division of Fluid Dynamics, Nov. 18-20, 2018, Atlanta, GA.
21. Sarma L. Rani and Donald L. Koch, "Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence. II. Comparison of Theory and DNS," American Physical Society 71st Annual Meeting of the Division of Fluid Dynamics, Nov. 18-20, 2018, Atlanta, GA.
22. Chao Zhang, Yuchen Liu, Lian Duan, and Sarma L. Rani, "The Interaction of a Homogeneous Field of Acoustic Waves with a Shock Wave," American Physical Society 71st Annual Meeting of the Division of Fluid Dynamics, Nov. 18-20, 2018, Atlanta, GA.

## INVITED SEMINARS

- "A Stochastic Model for High Stokes Number Particle Pair Dynamics in Isotropic Turbulence," Cornell University, January 22nd, 2013.
- "A Stochastic Model for High Stokes Number Particle Pair Dynamics in Isotropic Turbulence," Tata Institute of Fundamental Research (TIFR), Hyderabad, India, June 10th, 2013.
- "Stochastic Theories for Particle Pair Dynamics in Isotropic Turbulence," Atmospheric Science Department, University of Alabama in Huntsville, February 9th, 2015.
- "Investigation of Numerical Viscosities and Dissipation Rates of Shock-Capturing Schemes in Implicit Large-Eddy Simulation," Indian Institute of Technology Gandhinagar, India, May 8, 2017.
- "Analytical Investigation of Thermoacoustic Instabilities in Premixed Combustion Systems," Indian Institute of Technology Gandhinagar, India, May 9, 2017.
- "On the Neumann Boundary Condition for the Acoustic-Wave Helmholtz Equation, and the Relationship between Pressure and Density Fluctuations," IIT Kanpur, October 2019.
- "Stochastic Theory for the Clustering of Rapidly Settling, Low-Inertia Particle Pairs in Isotropic Turbulence," IIT Madras, October 2019.
- "On the Neumann Boundary Condition for the Acoustic-Wave Helmholtz Equation, and the Relationship between Pressure and Density Fluctuations," IIT Madras, October 2019.
- "On the Neumann Boundary Condition for the Acoustic-Wave Helmholtz Equation, and the Relationship between Pressure and Density Fluctuations," IIT Hyderabad, October 2019.

## FUNDING SINCE JOINING UAH

### Federal and State Grants

1. **Role:** Principal Investigator  
**Proposal Title:** The Role of Microphysical Processes and Turbulence Intermittency in Droplet Coalescence in Warm Cumulus Clouds

**Funding Amount:** \$173,642  
**Funding Agency:** NSF  
**Performance Period:** 09/01/2014 – 08/31/2020

2. **Role:** Principal Investigator  
**Proposal Title:** Investigating the Role of Turbulence in Warm-Cloud Precipitation  
**Funding Amount:** \$28,552 + ~ \$3.32 million equivalent computational resources (8.3 million node hours on the NCSA Blue Waters supercomputer; monetary value of these node hours is an NSF estimate)  
**Funding Agency:** NSF  
**Performance Period:** 08/01/2015 – 07/31/2018
3. **Role:** Principal Investigator  
**Proposal Title:** Multi-Scale Modeling of Radiative Heat Transfer in Hypersonic Flows  
**Funding Amount:** \$16,000  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2017 – 01/31/2018
4. **Role:** Principal Investigator  
**Proposal Title:** Multi-Scale Modeling of Radiative Heat Transfer in Hypersonic Flows  
**Funding Amount:** \$16,000  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2018 – 01/31/2019
5. **Role:** Principal Investigator  
**Proposal Title:** Multi-Scale Modeling of Radiative Heat Transfer in Hypersonic Flows  
**Funding Amount:** \$32,323  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2016 – 01/31/2017
6. **Role:** Principal Investigator  
**Proposal Title:** Prediction of Combustion Dynamics in Rocket Engines through Computational Enhancements in Loci-CHEM  
**Funding Amount:** \$43,048  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2015 – 09/17/2015
7. **Role:** Principal Investigator  
**Proposal Title:** Prediction of Combustion Dynamics in Rocket Engines through Computational Enhancements in Loci-CHEM  
**Funding Amount:** \$41,367  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2014 – 01/31/2015
8. **Role:** Principal Investigator  
**Proposal Title:** Prediction of Combustion Dynamics in Rocket Engines through Computational Enhancements in Loci-CHEM  
**Funding Amount:** \$41,106  
**Funding Agency:** NASA/GSFC  
**Performance Period:** 02/01/2013 – 01/31/2014



9. **Role:** Principal Investigator  
**Proposal Title:** A Novel Statistical Narrow-Band Model for Non-Gray Radiative Heat Transfer in Hypersonic Flight  
**Funding Amount:** \$50,000  
**Funding Agency:** Alabama State (Graduate Research Scholars Program)  
**Performance Period:** 08/01/2018 – 07/31/2020
10. **Role:** Principal Investigator  
**Proposal Title:** Novel Computational Framework for Radiative Heat Transfer in Hypersonic Flows  
**Funding Amount:** \$75,000  
**Funding Agency:** Alabama State (Graduate Research Scholars Program)  
**Performance Period:** 08/01/2016 – 07/31/2019
11. **Role:** Principal Investigator  
**Proposal Title:** Large Eddy Simulations of Turbulent Flows using Non-Dissipative, Temporally and Spatially High-Order, and High Efficiency Unstructured Grid Flow Solver  
**Funding Amount:** \$75,000  
**Funding Agency:** Alabama State (Graduate Research Scholars Program)  
**Performance Period:** 08/01/2013 – 07/31/2016  
 (First ever GRSP Award in the MAE Department at UAH)
12. **Role:** Principal Investigator  
**Proposal Title:** Investigation of the Wide Band and Narrow Band Models for Non-Gray Radiative Heat Transfer  
**Funding Amount:** \$25,000  
**Funding Agency:** Pat Roberts' Intelligence Scholars Program  
**Performance Period:** 05/31/2016 – 05/30/2017

## UAH Grants

1. **Role:** Principal Investigator  
**Proposal Title:** Spatial and Orientational Dynamics of Non-Spherical Particles in Turbulent Flows through Heterogeneous CPU+GPU Supercomputing  
**Funding Amount:** \$36,811  
**Funding Agency:** University of Alabama in Huntsville (Internal IIDR Solicitation)  
**Performance Period:** 08/01/2017 – 07/31/2018
2. **Role:** Principal Investigator  
**Proposal Title:** Precipitation Formation in Warm Cumulus Clouds  
**Funding Amount:** \$36,552  
**Funding Agency:** University of Alabama in Huntsville (Internal IIDR Solicitation)  
**Performance Period:** 06/01/2015 – 05/31/2016
3. **Role:** Principal Investigator  
**Proposal Title:** Combustion Instability Prediction in Rocket Engines through Computational Enhancements in Loci-Chem  
**Funding Amount:** \$33,089  
**Funding Agency:** University of Alabama in Huntsville (Internal IIDR Solicitation)  
**Performance Period:** 04/01/2013 – 03/31/2015

4. **Role:** Co-Principal Investigator  
**Proposal Title:** Optimal Feedback Control of Flow-Induced Instabilities Using Large Eddy Simulations  
**Funding Amount:** \$2,000  
**Funding Agency:** UAH  
**Performance Period:** 01/01/2015 – 12/31/2015
5. **Role:** Co-Principal Investigator  
**Proposal Title:** Understanding Precipitation Formation in Warm Cumulus Clouds  
**Funding Amount:** \$2,500  
**Funding Agency:** UAH  
**Performance Period:** 01/01/2015 – 12/31/2015

## **FUNDING AT CFD RESEARCH CORPORATION**

1. **Role:** PI  
**Proposal Title:** Computational Tool for Coupled Simulation of Nonequilibrium Hypersonic Flows with Ablation  
**Funding Amount:** \$700,000  
**Funding Agency:** NASA/Ames
2. **Role:** Co-PI  
**Proposal Title:** Efficient Computational Tool for Comprehensive Thermal Analysis of Military Ground Vehicles  
**Funding Amount:** \$100,000  
**Funding Agency:** U.S. Army
3. **Role:** Co-PI  
**Proposal Title:** A Mesoscale Modeling Tool for Heterogeneous Explosives with Accurate Multi-Physics Models and Detailed Chemical Kinetics  
**Funding Amount:** \$100,000  
**Funding Agency:** U.S. Air Force, Eglin, FL
4. **Role:** PI  
**Proposal Title:** Hybrid Approach for Multi-Scale Modeling of Radiation Transfer in Three-Dimensional Non-gray Media  
**Funding Amount:** \$100,000  
**Funding Agency:** AFOSR, Arlington, VA
5. **Role:** PI  
**Proposal Title:** Fuel/Oxidizer Injector Modeling for Deep Throttling Cryogenic Engines  
**Funding Amount:** \$165,000  
**Funding Agency:** NASA MSFC, Huntsville, AL
6. **Role:** PI  
**Proposal Title:** Advanced Non-Gray Radiation Module in the LOCI Framework for Combustion CFD  
**Funding Amount:** \$600,000  
**Funding Agency:** NASA MSFC, Huntsville, AL

7. **Role:** PI

**Proposal Title:** Advanced Non-Gray Radiation Module in the LOCI Framework for Combustion CFD

**Funding Amount:** \$100,000

**Funding Agency:** NASA MSFC, Huntsville, AL

8. **Role:** PI

**Proposal Title:** Combined Linear/Nonlinear Reduced-Order Analysis Tool for Predicting Dynamic and Static Instabilities in Gas Turbine Augmentors Funding

**Funding Amount:** \$100,000

**Funding Agency:** AFRL, Wright-Patterson AFB, Dayton, OH

## TEACHING

University of Alabama in Huntsville (2009-present)

- MAE 310 – Fluid Mechanics I
- MAE 488 – Analysis of Engineering Systems
- MAE 645 – Combustion I
- MAE 745 – Combustion II
- MAE 651 – Viscous Fluid Mechanics
- MAE 693 – Graduate Engineering Mathematics II
- MAE 695 – Special Topics (Cloud Physics; Combustion Instability)

## GRADUATE STUDENT ADVISING

### Current Students

|                                            |    |                             |
|--------------------------------------------|----|-----------------------------|
| 1. Mr. Sattik Basu (Ph.D.)                 | AE | August 2017 – present       |
| 2. Mr. Amit Avhad (Ph.D.)                  | ME | August 2018 – December 2019 |
| 3. Ms. Swarnalatha K. Vasanthkumar (Ph.D.) | AE | May 2020 – present          |
| 4. Mr. Joshua Fowler (M.S.)                | AE | January 2020 onwards        |

### Students Graduated

Master's

- Mr. Vijaya Krishna Rani (M.S.), Mechanical Engineering, "A Theoretical Study of the Complete Acoustics of a Duct with Multiple Discontinuities in Cross-Section," September 2011 – April 2013
- Ms. Kiruthika Sundararajan (M.S.), Mechanical Engineering, "Direct Numerical Simulations of the Relative Motion of Low Inertia Particles in Isotropic Turbulence," September 2015 – December 2017
- Mr. Sattik Basu (M.S.), Aerospace Engineering, "On the Neumann Boundary Condition for the Acoustic-Wave Helmholtz Equation, and the Relationship between Pressure and Density Fluctuations," August 2017 – May 2019
- Mr. Hayden Arceneaux (M.S.), Aerospace Engineering, "High Order Central Differencing about a Cell Face using the Roe Scheme with Higher Order Reconstruction," August 2018 – August 2019

Ph.D.

- Mr. Bassem R. Girgis (Ph.D.), Mechanical Engineering, "Numerical Simulations of Plasma Dynamics using the Flowfield Dependent Variation (FDV) Method," September 2011 – April 2013

- Mr. Shreyas Bidadi (Ph.D.), Mechanical Engineering, “Investigation of Numerical Viscosities and Dissipation Rates of Shock-Capturing Schemes for Implicit Large-Eddy Simulation,” January 2012 – May 2015
- Mr. Rohit Dhariwal(Ph.D.), Mechanical Engineering, “Stochastic Theory and Direct Numerical Simulations of the Relative Motion of High-Stokes-Number Particles in Isotropic Turbulence,” October 2011 – December 2016 (Passed Dissertation Defense on October 26, 2016)
- Mr. Vijaya Krishna Rani (Ph.D.), Mechanical Engineering, “Analytical Investigation of Thermoacoustic Instabilities in Premixed Combustion Systems,” May 2013 – December 2017
- Ms. Annette S. Fisher (Ph.D.), Mechanical Engineering, “Development of Absorption-Coefficient-Based Narrow-Band Model and its Application to the Calculation of Radiative Heat Transfer in One- and Two-Dimensional Enclosures”, August 2016 – May 2019

## **POST-DOCTORAL RESEARCH ADVISING**

- Dr. Vijay Kumar Gupta, January 2016 – August 2017
- Dr. Annette Fisher, January 2020 – Ongoing

## **STUDENT RECOGNITIONS**

- Shreyas Bidadi, a past Ph.D. student, was recognized with the 2015 UAH College of Engineering Outstanding Graduate Student Award
- Shreyas Bidadi was selected for the Marie Curie Post-Doctoral Fellowship at CERFACS, Toulouse, France
- Rohit Dhariwal, a past Ph.D. student, was recognized with the 2016 UAH College of Engineering Outstanding Graduate Student Award
- Rohit Dhariwal was awarded the Alabama State Graduate Research Scholars Program grant (\$75,000 over 3 years)
- Vijaya Krishna Rani, a past Ph.D. student, was awarded the Alabama State Graduate Research Scholars Program grant (\$75,000 over 3 years)
- Sattik Basu, a current Ph.D. student, was awarded the Alabama State Graduate Research Scholars Program grant (\$50,000 over 2 years)
- Sattik Basu, a current Ph.D. student, was recognized with the 2016 UAH College of Engineering Outstanding Graduate Student Award

## **UNIVERSITY SERVICE**

- Served on the MAE Department Faculty Search Committee, 2012
- Served on the College of Engineering Dean’s Scholarship Award Committee for the North Alabama Regional Science Fair, 2012.
- Served on the MAE Department Faculty Search Committee, 2013.
- Served on the Display and Safety Committee for the North Alabama Regional Science Fair, 2013.
- Served on the College of Engineering Dean’s Scholarship Award Committee for the North Alabama Regional Science Fair, 2013.
- Served on the Committee for drafting the College of Engineering Strategic Plan, 2013.
- Served on the College of Engineering Dean’s Scholarship Award Committee for the North Alabama Regional Science Fair, 2014.
- Served on the Display and Safety Committee for the North Alabama Regional Science Fair, 2014.

- Served as an observer for a Doctor of Nursing thesis in the College of Nursing, 2014.
- Serving on the MAE Department Graduate Committee.
- Served on the Faculty Reappointment Committee of the Computer Science Department, 2019 and 2020.
- Served on the Faculty Reappointment Committee of the Electrical Engineering Department, 2020.

## **SERVICE TO THE PROFESSION**

### **NSF Service**

Served on NSF unsolicited proposal review panels for the

- Division of Particulate and Multiphase Flows, 2015
- Division of Advanced CyberInfrastructure (ACI), 2015
- Division of Advanced CyberInfrastructure (ACI), 2016
- Division of Atmospheric and Geospace Sciences (AGS), 2016

### **Journal Service**

Acted as referee for the

- Journal of Fluid Mechanics
- International Journal of Multiphase Flow
- Journal of Propulsion and Power
- Chemical Engineering Science journal
- Powder Technology journal
- Journal of Computational Physics
- ASME Journal of Thermal Science and Engineering Applications
- Experimental Thermal and Fluid Science

### **Professional Membership**

Member of the

- American Physical Society (APS)
- American Institute of Aeronautics and Astronautics (AIAA)