

Assistant Professor and Founding Faculty  
Coordinator, Graduate Studies in Applied Mathematics  
School of Natural Sciences  
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**RESEARCH INTERESTS**

My research interests lie in both the development and use of mathematical models and numerical methods for studying time-dependent problems of practical importance. Physical problems include fluid-structure interaction, rotating convection, geophysical fluid dynamics, turbulent flow, and structural dynamics. Numerical methods include finite elements, spectral elements, global spectral methods, and large-scale parallel computing.

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**EDUCATION****University of Colorado at Boulder**

PhD, Mechanical Engineering, 2002, Thesis: *Advanced Computational Techniques for the Analysis of 3-D Fluid-Structure Interaction with Cavitation*

MS, Mechanical Engineering, 1999, Thesis: *Advances in Computational Methods for Fluid-Structure-Interaction Problems*

**University of Wisconsin–Madison**

BS, Mechanical Engineering, 1997, graduated with distinction, Thesis: *The Vibration of Perforated Hemispherical Shells*

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**WORK & RESEARCH EXPERIENCE**

**Assistant Professor and Founding Faculty Member**, Applied Mathematics, School of Natural Sciences, Univ. of California, Merced July 2005–Present

**Expert Witness**, for Dreyer, Babich, Buccola & Callaham, Attorneys at Law, April–June 2008

**Maître de Conférences Invité (Visiting Assistant Professor)**, EGIM, Laboratoire de Modélisation en Mécanique à Marseille, France, July 2005, June 2007

**Research Associate**, Applied Mathematics, Univ. of Colorado at Boulder, Aug. 2003–July 2005

**Visiting Scientist**, CNRS, Laboratoire de Modélisation en Mécanique à Marseille, France, May–July 2004

**Subcontractor**, Prof. Thomas L. Geers, Univ. of Colorado at Boulder, Feb. 2003–Aug. 2003

**Research Assistant**, Mechanical Engineering, Univ. of Colorado at Boulder, 1997 - 2002

**Visiting Graduate Student**, University of Canterbury, Christchurch, New Zealand, Spring 2001

**Research Assistant and Program Coordinator**, Center for X-ray Lithography, UW–Madison, 1996 - 1997

**Research Assistant**, US Department of Energy, Los Alamos National Laboratory, NM, 1996

**Lab Assistant**, ME Computational Mechanics Laboratory, UW–Madison, 1996

**Student Intern**, Milwaukee Electric Tool Corporation, Brookfield, Wisconsin, Summer 1995, Jan. 1996

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**PUBLICATIONS** (may be found at <http://faculty.ucmerced.edu/msprague>)

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**Refereed Journal Publications**

**Submitted** (\* indicates corresponding author)

14. Long, M., **M.A. Sprague**, A.A. Grimes, B.D. Rich, and M. Khine\*, 3-D Shrinky-Dink vortex micromixer: Efficient mixing at low Reynolds numbers, *Applied Physics Letters*. Submitted for review on 14 October 2008.

**Published** (\* indicates corresponding author)

13. Ross\*, M., **M.A. Sprague**, C.A. Felippa, and K.C. Park, Treatment of acoustic fluid-structure interaction by localized Lagrange multipliers and comparison to alternative interface coupling methods, *Computer Methods in Applied Mechanics and Engineering*. (2008), DOI:10.1016/j.cma.2008.11.006 (in press and available online).
12. Ross\*, M., C.A. Felippa, K.C. Park, and **M.A. Sprague**, 2008, Treatment of acoustic fluid-structure interaction by localized Lagrange multipliers: Formulation, *Computer Methods in Applied Mechanics and Engineering* **187**, 3057–3079, DOI:10.1016/j.cma.2008.02.017.
11. Serre, E., **M.A. Sprague**, and R.M. Lueptow\*, 2008, Stability of Taylor-Couette flow in a finite-length cavity with radial throughflow, *Physics of Fluids* **20**, 034106 (10 pages).
10. **Sprague\***, **M.A.**, P.D. Weidman, S. Macumber, and P.F. Fischer, 2008, Tailored Taylor vortices, *Physics of Fluids* **20**, 014102 (9 pages).
9. **Sprague\***, **M.A.** and T.L. Geers, 2007, Legendre spectral finite elements for structural dynamics analysis, *Communications in Numerical Methods in Engineering*, DOI: 1002/cnm.1086. Published online 06 December 2007 (13 pages).
8. **Sprague\***, **M.**, K. Julien, E. Knobloch, and J. Werne, 2006, Numerical simulation of an asymptotically reduced system for rotationally constrained convection, *Journal of Fluid Mechanics* **551**, 141–174.
7. **Sprague\***, **M.A.** and T.L. Geers, 2006, A spectral-element/finite-element analysis of a ship-like structure subjected to an underwater explosion, *Computer Methods in Applied Mechanics and Engineering* **195**, 2149–2167.
6. **Sprague\***, **M.A.** and T.L. Geers, 2004, A spectral-element method for modeling cavitation in transient fluid-structure interaction, *International Journal for Numerical Methods in Engineering* **60**, 2467–2499.
5. **Sprague\***, **M.A.** and T.L. Geers, 2003, Spectral elements and field separation for an acoustic fluid subject to cavitation, *Journal of Computational Physics* **184**, 149–162.
4. **Sprague\***, **M.A.** and T.L. Geers, 2001, Computational approximations for near-free-surface shock analysis, *Shock and Vibration* **8**, 105–122.
3. **Sprague\***, **M.A.** and T.L. Geers, 1999, Response of empty and fluid-filled, submerged spherical shells to plane or spherical, step-exponential waves, *Shock and Vibration* **6**, 147–157.
2. **Sprague**, **M.**, W. Semke, R. Engelstad\*, E. Lovell, A. Chalupka, H. Löschner, and G. Stengle, 1998, Stencil mask distortion control using nonsymmetric perforation rings, *Microelectronic Engineering* **41/42**, 225–228.
1. Shamoun\*, B., **M. Sprague**, F. Bedford, and R. Engelstad, X-ray mask distortions during e-beam patterning, 1998, *Microelectronic Engineering* **41/42**, 283–286.

**Conference Proceedings**

6. Weidman, P.D., **M.A. Sprague**, S. Macumber, Tailored Taylor Vortices. *Proceedings of the 15<sup>th</sup> International Couette-Taylor Workshop*, Le Havre, France, July 9-12, 2007.
5. Serre, E., **M. Sprague**, P. Bontoux, R.M. Lueptow, The effect of radial through-flow on the stability of Taylor-Couette flow. *Proceedings of the 15<sup>th</sup> International Couette-Taylor Workshop*, Le Havre, France, July 9-12, 2007.
4. **Sprague, M.**, K. Julien, E. Serre, J.J. Sánchez-Álvarez, and E. Crespo del Arco, Pattern formation in Rayleigh-Bénard convection in a rapidly rotating cylinder, *Proceedings of the Fourth International Symposium on Turbulence and Shear Flow Phenomena*, 2005, pp. 1089-1094.
3. Serre, E., **M. Sprague**, E. Crespo del Arco, J.J. Sánchez-Álvarez, and F. Busse, 2005, Numerical investigations of transition to spatio-temporal chaos in rotating Rayleigh-Bénard convection, *Progress in Computational and Mass Transfers*, **1** 95–100.
2. Mikkelson, A., **M. Sprague**, R. Engelstad, E. Lovell, and D. Trost, Mechanical distortions in advanced optical reticles, *Proceedings of the 1998 SPIE Symposium on Emerging Lithographic Technologies II*, SPIE, Vol. 3331, pp. 601-611, 1998.
1. Fisher, A., **M. Sprague**, R. Engelstad, D. Laird, and S. Nash, Stability and stiffness characteristics of the National X-ray Mask Standard, *Proceedings of the SPIE 1997 Symposium on Electron-Beam, X-ray, EUV, and Ion-Beam Submicrometer Lithographies for Manufacturing*, 1997, pp. 288-298.

**PRESENTATIONS**


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(only listed are talks for which M. Sprague was presenting author)

**Invited Talks**

8. Numerical simulation of an asymptotically reduced system for rotationally constrained convection, Applied Mathematics Seminar, Univ. of California, Berkeley, March 2006
7. Numerical investigation of a reduced set of equations for rapidly rotating convection, Applied Mathematics Colloquium, Univ. of Colorado, Boulder, March 2005
6. Numerical investigation of a reduced set of equations for rapidly rotating convection, SIAM Undergraduate Chapter Seminar, Univ. of Colorado, Boulder, November 2004
5. Numerical simulation of a reduced set of equations for rapidly rotating convection, Laboratoire de Modélisation en Mécanique à Marseille, France, July 2004
4. A spectral-element method for modeling cavitation in transient fluid-structure interaction, Fast Algorithms Seminar, Univ. of Colorado, Boulder, November 2003
3. A spectral-element method for modeling cavitation in transient fluid-structure interaction, Department of Mechanical Engineering Graduate Seminar Series, Univ. of Colorado, Boulder, 2003
2. Mapped-domain analysis for underwater shock problems, Naval Surface Warfare Center, Carderock Division, July 2000
1. Characterization of the friction properties of ceramic powders, Material Science Seminar, Los Alamos National Laboratory, 1996

**Contributed Talks**

12. 3D shrinky-dink vortex micromixer: Efficient mixing at low Reynolds numbers, American Physical Society Division of Fluid Dynamics Meeting, San Antonio, TX, November 2008
11. Large-scale numerical simulation of rotationally constrained convection, American Physical Society Division of Fluid Dynamics Meeting, Salt Lake City, UT, November 2007

10. Numerical simulation of an asymptotically reduced system for rotationally constrained convection, SIAM Conference on Mathematical & Computational Issues in the Geosciences, Santa Fe, NM, March 2007
9. Numerical simulation of an asymptotically reduced system for rotationally constrained convection, SIAM Conference on Nonlinear Waves and Coherent Structures, Seattle, WA, September 2006
8. Spectral finite elements for structural dynamics analysis, United States Congress on Theoretical and Applied Mechanics, Boulder, CO, June 2006
7. Reduced equations for rapidly rotating convection in a cylinder, American Physical Society Division of Fluid Dynamics Meeting, Chicago, IL, November 2005
6. Pattern formation in Rayleigh-Benard convection in a rapidly rotating cylinder, Fourth International Symposium on Turbulence and Shear Flow Phenomena, Williamsburg, VA, June 2005
5. Numerical simulation of a reduced set of equations for rapidly rotating convection, American Physical Society Division of Fluid Dynamics Meeting, Seattle, WA, November 2004
4. Numerical simulation of a reduced set of equations for rapidly rotating convection on the tilted  $f$ -plane, American Geophysical Union Ocean Sciences Meeting, Portland, OR, February 2004
3. Numerical simulation of a reduced set of equations for rapidly rotating convection on the tilted  $f$ -plane, American Physical Society Division of Fluid Dynamics Meeting, East Rutherford, NJ, November 2003
2. A spectral-element method for modeling cavitation in transient fluid-structure interaction, 7<sup>th</sup> US National Congress on Computational Mechanics, Albuquerque, NM 2003
1. USA-CFA-based methods for near-free-surface shock analysis, 70<sup>th</sup> Shock and Vibration Symposium, Albuquerque, NM, 1999

### Posters

3. DNS of reduced equations for rotationally constrained nonhydrostatic flows, 15th Conference on Atmospheric and Oceanic Fluid Dynamics, Cambridge, MA, June 2005
2. Stability and stiffness characteristics of the national X-ray mask standard, SPIE 1997 Symposium on Electron-Beam, X-ray, EUV, and Ion-Beam Submicrometer Lithographies for Manufacturing, Santa Clara, CA, March 1997
1. Characterization of the friction properties of ceramic powders, American Ceramic Society Annual Meeting, Ohio, 1997

### Outreach Talks

5. Panel member at *Northern California Forum for Diversity in Graduate Education*, University of California, Berkeley, 08 November 2008
4. Applied mathematics graduate studies, *CSU Stanislaus Math and CS Speaker Series*, 25 April 2008
3. Computer simulations vs. the real world, *Frontiers of Science & Engineering Lecture Series*, Castle Science & Technology Center, Atwater, CA, 17 November 2007
2. Presentation regarding UC Merced Applied Math to Math and Physics students, Mariposa High School, 06 November 2007
1. Applied mathematics graduate studies, *CSU Stanislaus Math and CS Speaker Series*, 20 April 2007

**GRANTS**

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**Multi-scale modeling and computation of convective geophysical turbulence**

*Awarding Agency & Division:* NASA 2007 National Leadership Computing System (NLCS)

*Investigators:* PI: K. Julien (Univ. of Colorado); Co-PIs: M. Sprague, J. Werne (NWRA), J. Weiss (Univ. of Colorado)

*Award Description:* 1.25 million hours of CPU time on the 2048-processor Columbia supercomputer to perform numerical simulations for rotationally constrained convection.

*Award Period:* 01 April 2007 – 31 March 2008

**Hydrodynamics control by highly accurate numerical simulation and modelling of the filtering processes and membrane separation.**

*Awarding Agency:* Centre National de la Recherche Scientifique (CNRS, France)

*Investigators:* Co-PIs: E. Serre (CNRS), M. Sprague, R. Lueptow (Northwestern University)

*Award Description:* 8000 euro/year for three years to support travel of French researchers to collaborate with M. Sprague and R. Lueptow in the USA.

*Award Period:* 2006 – 2008

**JOURNAL REFEREE**

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- *Applied Numerical Mathematics*
- *ASME Journal of Vibration and Acoustics*
- *Computer Methods in Applied Mechanics and Engineering*
- *International Journal of Numerical Methods in Engineering*
- *International Journal of Numerical Methods in Fluids*
- *Fluid Dynamics Research*
- *Journal of Fluid Mechanics*
- *Journal of Physics A: Mathematical and Theoretical*
- *Journal of Sound and Vibration*

**TEACHING EXPERIENCE** (Course webpages and Student-Questionnaire results found on Homepage)

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**Assistant Professor, School of Natural Sciences, Univ. of California, Merced**

- Fall 2008: MATH 232 (graduate) – Numerical Methods for PDEs
- Fall 2008: MATH 299 (graduate) – University Teaching
- Fall 2007: MATH 21 – Calculus 1
- Fall 2007: MATH 131 – Numerical Analysis 1
- Spring 2007: MATH 232 (graduate) – Numerical Methods for PDEs
- Fall 2006: MATH 24 – Introduction to Linear Algebra & Differential Equations
- Fall 2005: MATH 21 – Calculus 1

**Postdoctoral Instructor, Applied Mathematics, Univ. of Colorado at Boulder**

- Fall 2004/Spring 2005: Intermediate Numerical Analysis I & II, Senior-level course
- Spring 2004: Calculus 1 for Engineers
- 2004–2005: Advised various research projects for graduate & undergraduate students
- Fall 2003: Calculus 1 for Engineers

**Adjunct Professor, Mechanical Engineering, Univ. of Colorado at Boulder**

- Spring 2003: Computational Methods, a required Senior-level course
- Spring 2003: Finite-Element Consultant: Guided Senior-Design groups with the finite-element-analysis portion of their projects.
- Fall 2002: System Dynamics, a required Senior-level course; Nominated for the Sullivan-Carlson Innovation in Teaching Award

**Substitute Lecturer**

- Engineering Math I and II, Vibrations, Fluid Dynamics, and Numerical Analysis (all graduate)

**Teaching Assistant**

- System Dynamics (undergraduate; Outstanding TA Award)
- Senior Lab (undergraduate)
- Vibrations (graduate)
- Engineering Math I (graduate)
- Computational Methods (undergraduate)

**Lead Graduate Teacher**, Graduate Teacher Program, University of Colorado, 1998–2000

**HONORS & AWARDS**

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- NSF VIGRE Postdoctoral Scholar, 2003 - 2005
- Young Investigator Fellowship, 7<sup>th</sup> US National Congress on Computational Mechanics, 2003
- Achievement Rewards for College Scientists (ARCS) Scholarship, 1999-2002
- Outstanding TA Award, Univ. of Colorado at Boulder, Mechanical Engineering, Fall 2001
- NSF Computer Science, Engineering, and Mathematics Scholarship (CSEMS), 2000/2001
- Graduate School University Fellowship, Univ. of Colorado at Boulder, 1997, 2000, 2002
- DOE Science & Engineering Research Semester (SERS) Fellowship, Fall 1996

**PROFESSIONAL SOCIETIES**

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- American Geophysical Union
- American Physical Society
- American Society of Mechanical Engineers
- Society for Industrial and Applied Mathematics