Paula C. Sanematsu

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Research summary: I employ computational fluid dynamics (CFD) and 3D vertex models to investigate the mechanics of biological tissue flows. I process and analyze image data, create image-based unstructured meshes to perform image-based simulations of flow and particle transport in porous media. I use high-performance and high-throughput computing (HPC, HTC) to develop algorithms, perform simulations, and conduct data analysis with the objective to answer scientific questions that will lead to relevant publications.

Appointments

2022–pres. Sr Research Computing Facilitator, FAS RC, Harvard University (HU)
2019–2022 Postdoctoral Researcher, Dept. of Physics, Syracuse University (SU)
2015–2019 Postdoctoral Researcher, Dept. of Petroleum Eng., Louisiana State University

Education

PhD in Engineering Science, Louisiana State Univ. (LSU), Baton Rouge, LA, 2015
Advisor: Dr. Clinton Willson; Co-advisor: Dr. Karsten Thompson

MS in Mathematics, Univ. of Tennessee Space Institute (UTSI), Tullahoma, TN, 2010
Advisor: Dr. KC Reddy; Co-advisor: Dr. John Steinhoff

BS in Applied Mathematics, Siena Heights Univ. (SHU), Adrian, MI, 2007
BA in Computer and Information Systems, Siena Heights Univ., Adrian, MI, 2007

Publications

Peer Reviewed

[1] **Sanematsu, P.C**, Erdemci-Tandogan, G., Patel, H., Retzlaff, E.M., Amack, J.D., Manning, L. 3D viscoelastic drag forces contribute to cell shape changes during organogenesis in the zebrafish embryo. Special Inaugural Issue of *Cells & Development* (2021). doi:10.1016/j.cdev.2021.203718

[2] **Sanematsu, P.C.**, Thompson, K., Willson, C. Pore-scale modeling of nanoparticle transport and retention in real porous materials. *Computers and Geosciences* (2019). doi: 10.1016/j.cageo.2018.10.010

[3] Molnar, I., **Sanematsu, P.C.**, Gerhard, J., Willson, C., O'Carroll, D. Quantified pore-scale nanoparticle transport in porous media and the implications for colloid filtration theory. *Langmuir* (2016). doi:10.1021/acs.langmuir.6b01233

[4] **Sanematsu, P.C.**, Shen, Y., Thompson, K., Yu, T., Wang, Y., Chang, D., Alramahi, B., Takibiri-Borujeni, A., Tyagi, M., Willson, C. Image-based Stokes flow modeling in bulk proppant packs and

propped fractures under high loading stresses. *Journal of Petroleum Science and Engineering* (2015). doi:10.1016/j.petrol.2015.09.017

[5] Steinhoff, J., Chitta, S., and **Sanematsu, P.C.**. Nonlinear localized dissipative structures for solving wave equations over long distances. In C. Constanda & P. J. Harris (Eds.), *Integral Methods in Science and Engineering – Computational and analytical aspects* (357–368). New York, NY: Springer (2011). doi:10.1007/978-0-8176-8238-5_33

In Preparation

[1] **Sanematsu, P.C.** Interactive 3D visualization and post-processing analysis of vertex-based unstructured polyhedral meshes with ParaView (preprint).

[2] Thompson, K., **Sanematsu, P.C.** When do voxels become roughness in image-based modeling?

[3] Shen, Y., Thompson, K., **Sanematsu P.C.**, Willson, C. Image-based modeling of inertial flow in bulk proppant packs and propped fractures under varying loading stresses.

[4] Manning, L., **Sanematsu, P.C.** Tissue flow and rheology.

Conference Paper

[1] **Sanematsu, P.**. Propagation of periodic waves using first order wave equation with wave confinement. AIAA Region II Student Conference, Destin, FL, April 8–9, 2020

Theses

[1] **Sanematsu, P.C.** (2015), *Image-based modeling of porous media using FEM and Lagrangian particle tracking*, Ph.D. Dissertation, Louisiana State University, 152 pages. https://digitalcommons.lsu.edu

[2] **Sanematsu, P.C.** (2010), *Propagation of Periodic Waves Using Wave Confinement*, M.S. Thesis, University of Tennessee Space Institute, 62 pages. https://trace.tennessee.edu

Funding

XSEDE Startup Allocation: Fluid-solid interactions during embryogenesis in the zebrafish, MCH210030. PI: Sanematsu (SU), Co-PIs: Manning (SU), Zhang (SU). 50,000 core hours on Expanse SDSC, 2021–2022.

NIH R01: Four-dimensional prediction and quantification of how physical forces impact organogenesis in zebrafish, 1R01HD099031-01A1. PI: Manning (SU), CO-PIs: Amack (SUNY Upstate), Hehnly (SU). **$2.1M**, 2020–2025.

Economic Development Assistantship:, Graduate School, Louisiana State University. PI: Willson (LSU). **$25k/year**, 2011-2015.

Teaching Experience

2019 Guest Lecturer, General Physics I, SU
2013, 2015 Teaching Assistant, Fluid Mechanics, LSU

Work Experience

2012–2015 Graduate Research Assistant, Eng. Science, LSU
2014–2014 Summer Intern, ExxonMobil Upstream Research Company, Houston, TX
2008–2011 Graduate Research Assistant, Dept. of Mathematics, UTSI
2005–2007 Computer Technician, Computer Services, SHU
2007–2007 Computer Technician, Lenawee Intermediate School Dist., Adrian, MI

Additional Training & Certifications

Developing Stellar Statements & Writing Efficiently and Productively, 2021
Syracuse University, NY (3 hours of lessons)

Scientific Writing Workshop with Dr. Elizabeth Paley, Jan and Dec 2020
Syracuse University, NY (9 hours of lessons total)

International High Performance Computing Summer School, 2017
University of Colorado Boulder, CO (40 hours of lessons)

Live Gold Leadership Conference, 2014
Louisiana State University, LA

Image Analysis for Porous Media Short Course and Workshop, 2011
University of Texas at Austin, TX (30 hours of lessons)

Mathematical Problems in Industry, 2010
Rensselaer Polytechnic Institute, NY (40 hours of lectures)

Graduate Student Mathematical Modeling Camp, 2010
Rensselaer Polytechnic Institute, NY (40 hours of lessons and problems)

Honors & Awards

Scholarships

2015 Research Assistantship, LSU (1 year)
2011 Economic Development Assistantship, LSU (4 years)
2008 Graduate Research Assistantship, UTSI (3 years)
2004 Soccer Scholarship, SHU (3.5 years)

Travel Grants

2017 Travel Grant, International HPC Summer School, Boulder, CO
2013 Student Travel Grant, American Geophysical Union Fall Meeting
2010 Travel Grant, Mathematical Problems in Industry, Rensselaer Polytechnic Institute
2010 Travel Grant, Grad. Student Math Modeling Camp, Rensselaer Polytechnic Institute

Research Awards

2012 Best presentation in “Advanced Simulations in Fluid Flow in Porous Media”, AIChE

Academic Awards

2007 Outstanding Student Award, Computing, Mathematics and Science Division, SHU
2007 Mathematics Outstanding Senior Award, SHU
2007 Computer & Information Systems Outstanding Senior Award, SHU
2007 All-American Student-Athlete, NAIA
2007 All-Conference Student-Athlete, WHAC
2006 All-American Student-Athlete, NAIA
2006 All-Conference Student-Athlete, WHAC
2005 Mathematics Outstanding First Year Student Award, SHU
2004 Dean's List, SHU (6 semesters)

Other Skills & Qualifications

Computer Skills

Languages: C++, Fortran, Python, Java
Languages (basic): C, C#
Platforms: Linux, Windows, Mac
Math: MATLAB, Mathematica, Maple
Visualization: ParaView, Matlab, Avizo, Gnuplot, Octave, Matplotlib
Debugger: Allinea DDT, gdb, Microsoft Visual Studio
Editors: vim, Microsoft Visual Studio, Eclipse
Source code management: git, Microsoft Team Foundation Server
Image processing: ImageJ, Avizo
Statistics: Minitab, JMP
Other: Singularity, bash, LaTeX

Supercomputing

Experience with the following systems:

SuperMike-II cluster (146 TFlops) @ Louisiana State University
Philip cluster (3.5 Tflops) @ Louisiana State University
Expanse cluster (5.16 Pflops Tflops) @ San Diego Supercomputer Center
OrangeGrid distributed system (14,000 cores) @ Syracuse University
Stampede cluster (2 Pflops, decomissioned) @ Texas Advanced Computing
Bridges cluster (1.3 PFlops, decomissioned) @ Pittsburgh Super Computing

Languages

English (fluent) *Portuguese* (native speaker) *Spanish* (advanced)

Service

Leadership

2021-present	Co-organizer, WiSE Writing Group, SU
2020-2021	Co-organizer, Soft Matter and Biophysics Seminar Series, SU
2017	Judge, Outstanding Student Paper Award, AGU Fall Meeting
2014	Judge, Junior Reservoir Project Poster Presentation, LSU
2013	Liaison Officer, SIAM Student Chapter, LSU
2010-2011	President, AIAA Student Chapter, UTSI
2009	Volunteer Assistant Coach, Tullahoma Middle School Girls' Soccer
2008, 2009	Senator, Student Government Association, UTSI
2006, 2007	Co-captain, SHU Women's Soccer
2004	Tutor, Boys and Girls Club, Adrian, MI

Outreach

2013	Programming Challenge for Girls (PC4G), LSU
2012	Mentor, Innovation through Institutional Integration, LSU
2012	Diversity Ambassador, Office of Diversity, Equity, and Inclusion, LSU

Affiliations

American Physical Society (APS)
Women in Science and Engineering (WiSE)
International Society for Porous Media (InterPore)
American Geophysical Union (AGU)

Presentations

Invited Talks

[1] **Sanematsu, P.**, Erdemci-Tandogan, G., Merkel, M., Patel, H., Amack, J.D., Manning, L.. *Tissue flow during development and its role in symmetry breaking in the zebrafish embryo*. Soft Matter and Biophysics Workshop, Syracuse University, Syracuse, NY, October 23, 2020

[2] **Sanematsu, P.**, Thompson, K., Willson, C.. *Image-based modeling of porous media using FEM and Langrangian particle tracking*. University of Western Ontario, London, ON, Canada. October 15, 2015

Conference Talks

[1] **Sanematsu, P.**, Erdemci-Tandogan, G., Merkel, M., Patel, H., Amack, J.D., Manning, L. *The role of tissue mechanics in symmetry breaking during organogenesis in the zebrafish embryo*. Abstract R11.00003. APS March Meeting (virtual), March 14–19, 2021

[2] **Sanematsu, P.**, Erdemci-Tandogan, G., Merkel, M., Amack, J.D., Manning, L. (2020) *Investigating cell shape changes during organogenesis using a 3D vertex model*. APS March Meeting (virtual talk), March 2–6, 2020.

[3] Thompson, K., **Sanematsu, P.**. *Multiscale, pore-scale modeling of fluid mechanics using digital images and direct numerical solutions on unstructured meshes*. INTERPORE 10th International Conference on Porous Media & Annual Meeting, Valencia, Spain, May 6–10, 2019

[4] Thompson, K., **Sanematsu, P.** A new algorithm for unstructured tetrahedral meshing of pore-scale digital images. INTERPORE 9th International Conference on Porous Media & Annual Meeting, Rotterdam, Netherlands, May 8–11, 2017

[5] Willson, C., **Sanematsu, P.**, Shen, Y., Thompson, K. Image-based modeling of flow through propped fractures under variable stress. Engineering Mechanics Institute Conference, Stanford, CA, June 16–19, 2015

[6] **Sanematsu, P.**, Willson, C., Thompson, K.. *Image-based modeling of flow transition from a Berea rock matrix to a propped fracture*. Abstract H34E-04. American Geophysical Union Fall Meeting, San Francisco, CA, December 9–13, 2013

[7] Shen, Y., **Sanematsu, P.**, Bradley, S., Willson, C., Takibiri Borujeni, A., Thompson, K., Tyagi, M.. *Insights from image-based modeling of fluid flow in bulk proppant packs and propped fractures under varying loading stress*. American Institute of Chemical Engineers Annual Meeting, Pittsburgh, PA, October 28–November 2, 2012

Posters

[1] **Sanematsu, P.**, Erdemci-Tandogan, G., Merkel, M., Himani, P., Amack, J.D., Manning, L. *The role of tissue flow and tissue-scale rheology in symmetry breaking during organogenesis in the zebrafish embryo*. EMBO | EMBL Symposium: Life at the Periphery: Mechanobiology of the Cell Surface (virtual), March 2–3, 2021

[2] **Sanematsu, P.**, Erdemci-Tandogan, G., Merkel, M., Amack, J.D., Manning, L. *Investigating cell shape changes during organogenesis using a 3D vertex model*. The Physics of Collective Cell Migration, The Physics of Collective Cell Migration, Princeton, NJ, January 15–17, 2020

[3] **Sanematsu, P.**, Thompson, K., Willson, C. *Imaged-based pore-scale modeling of fluid flow and nanoparticle transport through porous media using finite element method and Lagrangian particle tracking*. INTERPORE 9th International Conference on Porous Media & Annual Meeting, Rotterdam, Netherlands, May 8–11, 2017

[4] **Sanematsu, P.**, Thompson, K., Willson, C. *Image-based modeling of porous media using FEM and Lagrangian particle tracking*. Advanced Energy Consortium All Projects Review, Houston, TX, November 18–19, 2015

[5] **Sanematsu, P.**, Thompson, K., Willson, C. *Nanoparticle transport in porous media using finite element method flow modeling and Lagrangian particle tracking*. Advanced Energy Consortium All Projects Review, Houston, TX, November 19–20, 2014

[6] **Sanematsu, P.** *Well path planning algorithms*. ExxonMobil Upstream Research Company Engineering Intern Poster Session, Houston, TX, July 30, 2014

[7] Mills, G., **Sanematsu, P.**, Mirsaeidi, A., Willson, C., Thompson, K. *Image-Based Pore-Scale Modeling*. Advanced Energy Consortium All Projects Review, Cambridge, MA, June 3–4, 2014

[8] **Sanematsu, P.** *Enhancing oil-and-gas productivity through image-based modeling of hydraulic fractures and nanosensor transport*. Tenth Annual Economic Development Assistantship Symposium, Louisiana State University, Baton Rouge, LA, April 28, 2014

[9] **Sanematsu, P.**, Willson, C., Thompson, K. *An imaged-based model of nanoparticle transport in porous media*. Third Annual Civil and Environmental Engineering Graduate Student Research Conference, Louisiana State University, Baton Rouge, LA, March 21, 2014

[10] **Sanematsu, P.**, Willson, C., Thompson, K. *Image-Based Nanoparticle Transport in Porous Media*. Advanced Energy Consortium All Projects Review, Houston, TX, November 20–21, 2013

[11] **Sanematsu, P.**, Shen, Y., Willson, C., Thompson, K.. *Understanding rock-proppant-fracture systems using x-ray computed tomography image-based network and finite element modeling*. 54th SPWLA International Technical Symposium, New Orleans, LA, June 22–26, 2013

[12] **Sanematsu, P.**. *X-Ray computed micro tomography and quantification of rock/proppant systems under high loading stress*. Second Annual Civil and Environmental Engineering Graduate Student Research Conference, Louisiana State University, Baton Rouge, LA, March 15, 2013