

DI PU

Dept. of Chemical and Physical Sciences, University of Toronto Mississauga, Mississauga, ON L5L 1C6

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RESEARCH INTERESTS

- Microfluidics, Soft matter & Biosensing
- Interfacial transport phenomena at the micro- and nanoscale
- Colloid thermophoresis and thermo-osmotic flows
- Biosensing platforms for clinical biomarker profiling

PROFESSIONAL EXPERIENCE & EDUCATION

University of Toronto Mississauga Dept. of Chemical and Physical Sciences <i>Postdoctoral Research Associate</i>	Jun. 2025 – Present Mississauga, Canada
University of Calgary <i>Ph.D. in Chemical Engineering</i>	Sep. 2019 – Mar. 2025 Calgary, Canada
University of Regina <i>M.A.Sc. in Petroleum Systems Engineering</i>	Sep. 2015 – Apr. 2019 Regina, Canada
Southwest Petroleum University <i>B.Eng. in Petroleum Engineering</i>	Sep. 2010 – Jul. 2014 Chengdu, China

PUBLICATIONS

Journal papers:

5. John, J., Panahi, A., **Pu, D.** and Natale, G., 2024. *Progress in Rheology of Active Colloidal Systems. Current Opinion in Colloid & Interface Science*, 75, p. 101886.
4. **Pu, D.**, Panahi, A., Natale, G. and Benneker, A.M., 2024. *Colloid Thermophoresis in Surfactant Solutions: Probing Colloid-Solvent Interactions Through Microscale Experiments. J. Chem. Phys.*, 161 (10), p. 104701.
3. Panahi, A., **Pu, D.**, Natale, G. and Benneker, A.M., 2024. *Polymer Concentration Regimes from Fractional Microrheology. Journal of Rheology*, 68 (6), pp. 849–862.
2. **Pu, D.**, Panahi, A., Natale, G. and Benneker, A.M., 2024. *A Mode-Coupling Model of Colloid Thermophoresis in Aqueous Systems: Temperature and Size Dependencies of the Soret Coefficient. Nano Letters*, 24 (9), pp. 2798–2804.
1. **Pu, D.**, Panahi, A., Natale, G. and Benneker, A.M., 2023. *Colloid Thermophoresis in the Dilute Electrolyte Concentration Regime: From Theory to Experiment. Soft Matter*, 19 (19), pp. 3464–3474.

Patents:

2. Natale, G., Benneker, A.M., Panahi, A., **Pu, D.**, 2026. *Thermophoretic PFAS detection platform*. Patent application pending.
1. **Pu, D.**, 2022. *A Real-Time Visualization Window for Dynamic Observation of Foamy Oil Flow*. Chinese Patent CN217132972U. Filed Dec. 28, 2021, issued Aug. 5, 2022. *Commercialized and adopted by research laboratories.*

MANUSCRIPTS UNDER REVIEW AND IN PREP

2. Panahi, A., **Pu, D.**, Natale, G. and Benneker, A.M., 2026. *Van der Waals Interactions in Ternary Systems through Thermophoresis*. Manuscript submitted for publication.
1. Panahi, A., **Pu, D.**, Natale, G. and Benneker, A.M., 2026. *Detection of PFAS-laden Microplastics by Thermophoresis*. Manuscript under review.

TALKS & POSTERS

4. Thermophoresis in aqueous systems, University of Toronto, Toronto, Canada (Online), Feb. 2025 (Invited Speaker, 40 min. talk)
3. Design and implementation of a novel thermophoretic device for the separation of colloids, 38th Conference of European Colloid & Interface Society, Copenhagen, Denmark, Sep. 2024 (Poster, co-author)
2. A mode-coupling model of colloid thermophoresis in aqueous media: probing the interactions in many body systems, Canadian Chemical Engineering Conference 2023, Calgary, AB, Oct. 2023 (20 min. talk)
1. Theory and experiment on colloid thermophoresis in aqueous media using lab-on-a-chip platforms, Canadian Chemical Engineering Conference 2022, Vancouver, BC, Oct. 2022 (20 min. talk)

RESEARCH EXPERIENCE

Postdoctoral Researcher

Jun. 2025 – Present

The Ogata Lab, University of Toronto Mississauga

- Project: Ultrasensitive Protein Biomarker Profiling for Endometriosis Stratification
- Project: Noninvasive Steroid Hormone Detection via Thermophoretic Biosensing

Graduate Student Researcher

Sep. 2019 – Mar. 2025

MicroTransport Lab & Complex Fluids Laboratory, University of Calgary

- Developed a thermofluidic platform with femto-Newton sensitivity for probing chemical interactions at the nano- and microscales.
- Realistic modeling of multiscale interactions at solid-liquid interfaces to understand the origins of temperature and size dependencies of the transport behavior of nano- and micron-sized colloids in electrolyte solutions.
- Combined capillary electrophoresis–thermophoresis (CET) experiments with a complex network–based mechanistic model to quantify the coupled effects of temperature, surface chemistry, and interfacial interactions at silica–water interfaces, enabling physics-informed modeling and AI-assisted interpretation of thermally nonequilibrium transport phenomena.
- Microfluidic studies on the thermocapillary migration of surfactant-laden droplets, focusing on microscopic mechanisms underlying interfacial tension gradient-driven flows relevant to liquid-liquid phase separations.
- Led and facilitated training programs for lab staff, focusing on experimental techniques, image analysis, and laboratory safety protocols.

Graduate Student Researcher

Sep. 2015 – Apr. 2019

Faculty of Engineering & Applied Science, University of Regina

- Developed a chip-scale platform for *in situ* physicochemical characterization of gas-in-oil dispersions under high-pressure conditions.
- Mechanistic study of nonequilibrium phase behavior in CH₄/CO₂/heavy oil systems & its relevance to bubble nucleation, growth and coalescence.
- Collaborated with international industrial and academic partners on reservoir fluid sampling and post-analysis to support projects with Shaanxi Yanchang Petroleum Group and Southwest Petroleum University.
- Supported EVRAZ Wasco Pipe Protection Corporation in the physicochemical characterization of pipeline coating fluids for industrial applications.

Undergraduate Student Researcher

Sep. 2010 – Jul. 2014

School of Oil & Nature Gas Engineering, Southwest Petroleum University

- Application of the Langmuir adsorption model for shale gas reserve estimation.

MENTOR EXPERIENCE

1. Melissa D’Amaral, University of Toronto Mississauga, graduate research 2025 – now
2. Abigail Richards, University of Toronto Mississauga, graduate research 2025 – now

TEACHING EXPERIENCE

Teaching Assistant of ENCH 403: Heat Transfer (Laboratory Tutoring/Supervising) Fall 2021
University of Calgary Calgary, AB

SERVICE

Symposium Co-organizer May. 2026 (upcoming)
Point-of-Need Sensing to Impact Society: Where Chemistry Meets Engineering
Analytical Chemistry, Canadian Societies for Chemistry and Chemical Engineering Conference and Exhibition

Reviewer Apr. 2024 - now
Physics of Fluids, Chemical Engineering Science

ADVANCED RESEARCH TRAINING

Lab2Market Discover – National Health, Cardiovascular (accepted) Feb. 2026 – Apr. 2026
Lab2Market National Program (Canada)

Stat & QuantPhys Winter School on “Statistical Physics and Quantum Physics” Feb. 2024
Analytical Quantum Complexity RIKEN Hakubi Research Team & Hatano Laboratory

AWARDS, GRANTS & HONOURS

Canada First Research Excellence Fund (CFREF) Program Sep. 2019 – Jan. 2025

The Graduate Excellence Award Winter 2024

The Graduate Excellence Award Fall 2020

Line Faculty Scholarship Fund Award Fall 2017

Faculty of Graduate Studies and Research Graduate Scholarship Fall 2017

SKILLS

Microfluidics & device systems: Device design (AutoCAD), thermal and flow control systems, droplet microfluidics & soft lithography.

Nanomaterials and interfacial engineering: Nano- and microparticle synthesis, surface chemistry engineering, molecularly imprinted polymers (MIPs) & bioconjugation.

Biosensing and analytical platforms: SiMoA HD-X analyzer, fluorescence intensity and lifetime imaging, bright-field microscopy, dynamic light scattering (DLS), scanning electron microscopy (SEM), FTIR, capillary electrophoresis, microscale thermophoresis, pendant drop tensiometry & rheological/density measurements.

Theoretical modeling & machine learning: Nonequilibrium statistical physics, surface thermodynamics, low-Reynolds-number hydrodynamics, physics-informed modeling, COMSOL Multiphysics & Python/MATLAB-based computational analysis.

REFERENCES

Dr. Alana Ogata
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Dr. Anne Benneker
Associate Professor, Dept. of Chemical and Petroleum Engineering
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Dr. Giovanniantonio Natale
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Curriculum Vitae
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