

# DI PU

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## RESEARCH INTERESTS

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- Microfluidics, Soft matter & Biosensing
- Interfacial Transport Phenomena at the Micro- and Nanoscale
- Colloid Thermophoresis and Thermo-osmotic Flows
- Multi-omics Biomarker Discovery & Ultrasensitive Bioanalysis
- Statistical Physics & Topological Modeling of Complex Diseases

## PROFESSIONAL EXPERIENCE & EDUCATION

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

## PUBLICATIONS

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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, 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. The Journal of Chemical Physics*, 161(10), 104701.
3. Panahi, A., **Pu, D.**, Natale, G., and Benneker, A.M. (2024). *Polymer Concentration Regimes from Fractional Microrheology. Journal of Rheology*, 68(6), 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), 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), 3464–3474.

## SUBMITTED MANUSCRIPTS

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2. Panahi, A., **Pu, D.**, Natale, G., and Benneker, A.M. (2026). *Van der Waals Interactions in Ternary Systems through Thermophoresis*. Submitted.
1. Panahi, A., **Pu, D.**, Natale, G., and Benneker, A.M. (2026). *Detection of PFAS-Laden Microplastics by Thermophoresis*. Under review.

## PATENTS

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2. Natale, G., Benneker, A.M., Panahi, A., and **Pu, D.** (2026). *Colloid-Based Thermophoretic Technology for PFAS Detection*. U.S. Provisional Patent Application No. 63/975,580, filed Feb. 4, 2026. Technology transfer via Innovate Calgary (Tech ID #2026-043).
1. **Pu, D.** (2022). *A High-Pressure Visual Cell for In-Situ Observation of Foamy Oil Flow*. Chinese Patent CN217132972U, filed Dec. 28, 2021; issued Aug. 5, 2022. Commercialized and adopted by research laboratories.

## TALKS & POSTERS

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5. Characterizing molecular heterogeneity and disease-associated signatures for endometriosis, 2026 CRS Women's Health Symposium: Innovation in Technology Development & Clinical Translation, Toronto, Canada, Sep. 2026 (Poster, accepted).
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

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### Postdoctoral Fellow

Jun. 2025 – Present

The Ogata Lab, University of Toronto Mississauga

Research support: Canadian Institutes of Health Research (CIHR)

- **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

Research support: Canada First Research Excellence Fund (CFREF)

- 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 CH<sub>4</sub>/CO<sub>2</sub>/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

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|------------------------------------------------------------------------------|------------|
| 1. Melissa D’Amaral, University of Toronto Mississauga, graduate research    | 2025 – now |
| 2. Abigail Richards, University of Toronto Mississauga, graduate research    | 2025 – now |
| 3. Humza Choudhry, University of Toronto Mississauga, undergraduate research | 2026 – now |

## TEACHING & PEDAGOGICAL TRAINING

### Teaching in Higher Education (THE500)

University of Toronto

Fall 2026

Toronto, ON

### Teaching Assistant of ENCH 403: Heat Transfer (Laboratory Tutoring/Supervising)

University of Calgary

Fall 2021

Calgary, AB

## SERVICE

### Symposium Co-organizer

May. 2026

*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

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| <b>Lab2Market Discover – National Health, Cardiovascular (accepted)</b><br><i>Lab2Market National Program (Canada)</i>                                                            | Feb. 2026 – Apr. 2026 |
| <b>Stat &amp; QuantPhys Winter School on “Statistical Physics and Quantum Physics”</b><br><i>Analytical Quantum Complexity RIKEN Hakubi Research Team &amp; Hatano Laboratory</i> | Feb. 2024             |

## AWARDS, GRANTS & HONOURS

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|---------------------------------------------------------------|-------------|
| 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

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**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

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### **Dr. Alana Ogata**

Assistant Professor , Dept. of Chemical & Physical Sciences  
University of Toronto Mississauga  
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### **Dr. Anne Benneker**

Associate Professor, Dept. of Chemical and Petroleum Engineering  
University of Calgary  
[anne.benneker@ucalgary.ca](mailto:anne.benneker@ucalgary.ca)

### **Dr. Giovanniantonio Natale**

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University of Calgary  
[gnatale@ucalgary.ca](mailto:gnatale@ucalgary.ca)