BHAVYA BALU

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EDUCATION

Carnegie Mellon University (CMU) Pittsburgh, PA
Doctor of Philosophy in Chemical Engineering (**GPA:** 3.8/4.0) *Anticipated May 2021*
Research: Mathematical modelling of charge transport dynamics in electrochemical systems

Indian Institute of Technology Madras Chennai, India
Bachelor of Technology (with Honors) in Chemical Engineering (**GPA:** 8.9/10.0) *May 2016*
Research: Computational modelling of droplet behavior in 2D microchannels

THESIS

Carnegie Mellon University Pittsburgh, PA
Advisor: Prof. Aditya S. Khair

Thesis title: Mathematical modelling of charge transport dynamics in asymmetric electrolytes

- Diffusiophoresis of particles in asymmetric electrolytes at arbitrary Debye lengths *Aug 2020 - present*
  - Derived analytically the diffusiophoretic velocity of a charged colloidal particle in a salt concentration gradient
  - Generalized theory to include the effect of unequal ion valences and arbitrary screening lengths
- Phoretic particle motion in asymmetric rectified electric fields *Jan 2020 - Jul 2020*
  - Formulated analytically the nonlinear response of an asymmetric electrolyte under an ac voltage
  - Predicted time averaged velocity of a colloidal particle in electrolyte due to such a rectified electric field
- Dynamic double layer force between two surfaces in electrolyte *Apr 2019 - Dec 2019*
  - Developed new theory describing non-equilibrium force between two electrodes under a time dependent voltage
  - Estimated non-equilibrium force that is orders of magnitude larger than the equilibrium value
- Role of Stefan-Maxwell fluxes in the dynamics of concentrated electrolytes *Jan 2017 - July 2018*
  - Formulated modified governing equations for ion transport dynamics in concentrated electrolytes
  - Extracted the time scales for charging of an electrochemical cell using asymptotic analysis

ADDITIONAL GRADUATE RESEARCH

Carnegie Mellon University Pittsburgh, PA
Advisor: Prof. Aditya S. Khair

- Breaking electrolyte symmetry in Induced Charge Electroosmosis *May 2020 - Oct 2020*
  - Quantified effect of electrolyte asymmetry on fluid flow around a conducting cylinder under ac voltage
  - Predicted salt disturbance due to ionic asymmetry modifies the induced charge electrokinetic flow
- Lift force on a charged sphere that translates and rotates in an electrolyte *Dec 2018 - Jan 2019*
  - Explained deflection of charged spheres in microchannel flow as observed by previous experiments
  - Solved numerically the coupled boundary value problem for the electrokinetics and fluid dynamics

UNDERGRADUATE RESEARCH

Indian Institute of Technology Madras Chennai, India

Bachelor's Thesis Project

Advisor: Prof. Raghunathan Rengaswamy

Title: Destabilization due to coalescence in 2D poly-disperse micro-emulsions *Aug 2015 - April 2016*

- Extended a stochastic model for coalescence destabilization of micro-emulsions to include poly-dispersity

University of Alberta Edmonton, Alberta

MITACS Globalink Research Internship

Advisor: Prof. Aloke Kumar

Title: Modelling fluid flow through porous media *May 2015 - Aug 2015*

- Developed a computational model using COMSOL and conducted a parameter study for fluid flow through porous media

PUBLICATIONS

1. **B. Balu** and A. S. Khair, "A thin double layer analysis of asymmetric rectified electric fields (AREFs)," *under review*
2. A. S. Khair and **B. Balu**, "Breaking electrolyte symmetry in induced-charge electro-osmosis," *Journal of Fluid Mechanics (2020), 905, A20*
3. **B. Balu** and A. S. Khair, "Dynamic double layer force between charged surfaces," *Physical Review Research 2.1 (2020): 013138*
4. A. S. Khair and **B. Balu**, "The lift force on a charged sphere that translates and rotates in an electrolyte," *Electrophoresis 40.18-19 (2019): 2407-2414*
5. **B. Balu** and A. S. Khair, "Role of Stefan-Maxwell fluxes in the dynamics of concentrated electrolytes," *Soft Matter 14.41 (2018): 8267-8275*

CONFERENCES

1. **B. Balu** and A. S. Khair, "Particle motion in asymmetric rectified electric fields," *Annual Meeting of the American Institute of Chemical Engineers*, virtual conference, 19 November 2020, full length talk
2. **B. Balu** and A. S. Khair, "Dynamic double layer force between charged surfaces," *Annual Meeting of the American Institute of Chemical Engineers*, virtual conference, 20 November 2020, full length talk
3. **B. Balu** and A. S. Khair, "Role of Stefan-Maxwell fluxes in they dynamics of concentrated electrolytes," *International Symposium on Electrokinetics*, Boston, MA, 12 June 2019, poster with soundbite
4. **B. Balu** and A. S. Khair, "Role of Stefan-Maxwell fluxes in they dynamics of concentrated electrolytes," *Annual Meeting of the American Institute of Chemical Engineers*, Pittsburgh, PA, 1 November 2018, full length talk
5. P. Sivakumar, **B. Balu**, M. Danny Raj, R. Rengaswamy, "Soft matter meets machine learning: insights into the stability of poly-disperse emulsions," *CompFlu-17*, Chennai, India, December 2017, contributed work

FELLOWSHIPS & AWARDS

Toor Fellowship in Chemical Engineering, 2020; Mahmood I. Bhutta Fellowship in Chemical Engineering, 2019; Dean's Fellowship, 2016-17; MITACS Globalink Research Fellowship, 2015.

MENTORING & TEACHING

- Project mentor to Summer Undergraduate Research Intern at CMU *Summer 2018*
- Teaching Assistant, Physical Chemistry of Colloids and Interfaces *Spring 2018*
  Graduate course by Prof. Aditya S. Khair at CMU
- Teaching Assistant, Mathematical Techniques in Chemical Engineering *Fall 2017*
  Doctoral core course by Prof. Aditya S. Khair at CMU
- Teaching Assistant, Mathematical Methods of Chemical Engineering *Spring 2017*
  Sophomore course by Prof. Myung S. Jhon at CMU

SKILLS

Analytical Tools: Perturbation methods, asymptotic analysis, Laplace & Fourier transforms for partial differential equations

Languages and Software: Python, C/C++, MATLAB, COMSOL, Microsoft Excel, Inkscape

LEADERSHIP ROLES

Graduate Mentor, ChemE Car team, CMU *Jan 2020 - Dec 2020*
- Assist the CMU undergraduate ChemE Car team with research and experiment design

Department Representative, Graduate Student Assembly, CMU *Jan 2020 - Dec 2020*
- Voice concerns of the student body, vote on allocation of funds, and serve on graduate action committees

Outreach Coordinator, Chemical Engineering Graduate Student Association, CMU *Jan 2019 - Dec 2019*
- Initiated a series of outdoor community outreach events that doubled volunteer turnout
- Coordinated a food drive, fundraising campaign (raised $600), and volunteers for local STEM outreach.

Co-organizer, Chemical Engineering Industrial Career Seminar, CMU *May 2019 - May 2020*
- Organized 2 one-day professional development events inviting 5-6 industry professionals and senior graduate students

Alumni Affairs Secretary, Sharavati Hostel, IIT Madras *Aug 2014 - May 2015*
- Organized fundraisers, maintained alumni database and website, and held events for the graduating class of the hostel

PROFESSIONAL EXPERIENCE

Summer Internship, Forbes Marshall Chennai, India

Project title: Energy analysis of an autoclaved aerated concrete block plant *May 2014 - Aug 2014*
- Built a spreadsheet model to analyze the steam and power consumption in an autocalved aerated cement block manufacturing plant

SERVICE & OUTREACH

- Volunteer, Moving 4th into Engineering, Pittsburgh, PA *Apr 2019*
- Essay & Presentation Judge at Future City Regional Competition, Pittsburgh, PA *Jan 2019*
- Poster Judge at the Annual Meeting of AIChE, Pittsburgh, PA *Nov 2018*
- Volunteer, Engineers Week at the Carnegie Science Center, Pittsburgh PA *Feb 2017*