

BHAVYA BALU

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EDUCATION & TRAINING

Northwestern University

Postdoctoral Research Associate, Engineering Sciences and Applied Mathematics

Evanston, IL

from Sep 2021

Advisors: Prof. Petia Vlahovska and Prof. Michael Miksis

Research: Computational models for deformation of biological membranes under electric fields

Carnegie Mellon University (CMU)

Doctor of Philosophy in Chemical Engineering (**GPA:** 3.8/4.0)

Pittsburgh, PA

Jul 2021

Advisor: Prof. Aditya Khair

Thesis: Mathematical modelling of ion transport dynamics in asymmetric electrolytes

Indian Institute of Technology Madras

Bachelor of Technology (with Honors) in Chemical Engineering (**GPA:** 8.9/10.0)

Chennai, India

May 2016

Advisor: Prof. Raghunathan Rengaswamy

Research: Computational modelling of droplet behavior in 2D microchannels

THESIS

Carnegie Mellon University

Advisor: Prof. Aditya S. Khair

Pittsburgh, PA

- Asymptotic analysis of impedance spectra of asymmetric electrolytes *Jan 2021 - present*
 - Derived an asymptotic model describing the impedance response of asymmetric electrolytes under ac voltage
 - Identified two distinct physical phenomena that drive the observed impedance response at low and moderate frequencies
- Phoretic particle motion in asymmetric rectified electric fields *Jan 2020 - Dec 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 - Jul 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

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.

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. Alope 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, "Asymptotic approximations to the impedance of an asymmetric electrolyte," *under review*
2. **B. Balu** and A. S. Khair, "A thin double layer analysis of asymmetric rectified electric fields (AREFs)," *Journal of Engineering Mathematics* (2021), 129 (1), 1-18
3. A. S. Khair and **B. Balu**, "Breaking electrolyte symmetry in induced-charge electro-osmosis," *Journal of Fluid Mechanics* (2020), 905, A20
4. **B. Balu** and A. S. Khair, "Dynamic double layer force between charged surfaces," *Physical Review Research* 2.1 (2020): 013138
5. 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
6. **B. Balu** and A. S. Khair, "Role of Stefan-Maxwell fluxes in the dynamics of concentrated electrolytes," *Soft Matter* 14.41 (2018): 8267-8275

INVITED TALKS

1. **B. Balu** and A. S. Khair, "Particle motion in asymmetric rectified electric fields," *Emerging Engineers and Scientists Seminar Series*, Ohio State University, 8 November 2021, invited talk

CONFERENCE PRESENTATIONS

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

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: Differential equations, 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 autoclaved 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*