

Dr. Jai Prakash – Curriculum Vitae

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RESEARCH INTERESTS

Fluid Mechanics, Transport Phenomena, Flow Through Porous Media, Mathematical Modelling, Fractional calculus.

EDUCATION

- 2011** Ph.D. in Mathematics
Indian Institute of Technology
Kharagpur, Kharagpur-721302, India
Dissertation Topic : Hydrodynamics and Intraparticle Nutrient Transport Inside Porous Pellets
Advisors : Prof. G. P. Raja Sekhar and Prof. Sirshendu De
- 2004** Master of Science (M.Sc.) in Mathematics, 78.20%
Banaras Hindu University, Varanasi-221005, India
- 2002** Bachelor of Science (B.Sc.) in Physics and Mathematics, 71.05%
University of Allahabad, Prayagraj-211002, India

RESEARCH EXPERIENCE

- November 2024 -Present: Associate Professor at Banaras Hindu University, Varanasi–221005, INDIA.
- August 2019- November 2024: Associate Professor at Mahindra University, Hyderabad–500043, INDIA.
- July 2014- July 2019 : Assistant Professor at Mahindra École Centrale, Hyderabad–500043, INDIA.
- June 2017 : Visiting Professor at EM2C Laboratory, Ecole Centrale Paris.
- Oct. 2011- July 2014 : Post Doctoral Fellow at Department of Chemical Engineering, Technion- Israel.
- Jan. 2011- Sep. 2011 : NBHM Post Doctoral Fellow at Department of Mathematics, IIT Kharagpur, West Bengal, INDIA

- Sep. 2010- Nov. 2010 : Worked in a CSIR project titled “Singularity methods for Stokes flow in presence of planar interface ”, IIT Kharagpur, West Bengal, INDIA

RESEARCH PROJECT FUNDED BY EXTERNAL AGENCY

1. **Project Title:** Hydrodynamics of Bubbles/ Drops/ Soft Particles in Porous Media- Volume Averaging Approach. Funded by SERB- DST under MATRICS scheme (2018-2021, Completed).
2. **Project Title:** Effect of Marangoni stresses and interfacial rheology on migration and deformation of surfactant-laden drops in viscous flow. Funded by SERB-DST under CRG scheme (2023-2026).

STUDENT SUPERVISION:

1. Ch. Dhanya, Ph. D. Student at Mahindra University, Hyderabad. Defended her thesis on 27/06/2025 (Sole Supervisor).

Title of Thesis: **Hydrodynamics and migration of drops in a viscous flow under external gradient**

2. Priyadarshini Sahoo, Project student, worked on interfacial viscosity effect on migration of surfactant laden drop in unsteady flow.
3. Nandita Kundu, Ph.D. student enrolled at the North Bengal University. She is working on Electrophoresis of deformed charged colloidal particles (Co-Supervisor).

OVERVIEW OF RECENT RESEARCH WORK

1. Motion of bubbles and drops is ubiquitous in nature and it has variety of applications in several biological and industrial processes. Some examples of such applications are colloidal analysis and separation, food and chemical processing, pharmaceutical manufacturing, and blood flow in vessels. There have been numerous studies carried out on the slow motion of fluid drops and gas bubbles under various conditions, both experimentally and theoretically. Recently, our group has worked on the analytical treatment of the problem of steady translational motion of a slightly deformed spherical fluid drop suspended in an immiscible viscous fluid under the consideration of vanishing Reynolds number. This is the case when the induced stress is slightly higher than the interfacial tension so that the drop is slightly deformed but does not break. The flow fields in both the interior and exterior of the drop are governed by the steady Stokes equations that are solved asymptotically using a method of perturbed expansions under suitable boundary conditions. The deformation from spherical shape is characterized by a small parameter called the deformation parameter, and the hydrodynamic boundary value problem is solved up to the second order of the deformation parameter by neglecting the higher-order terms. The effect of deformation parameter is observed by means of force expression. The explicit expressions for the hydrodynamic drag force exerted on the drop are obtained for the special cases of prolate and oblate spheroids.

In the limiting cases of the drop behaving as a solid particle and a gas bubble, the force expressions agree with the corresponding formulas for the slow translation of a slightly deformed slip sphere in the limiting conditions of no slip and full slip, respectively.

2. We further investigated the problem of translational motion of a spheroidal drop where Stream function formulation is adopted to solve the hydrodynamic equations in both regions. The general solution for the stream function in prolate and oblate spheroidal coordinates is expressed in an infinite-series form of semi-separation of variables. The leading order coefficients in the stream function are obtained using suitable boundary conditions. The hydrodynamic drag force experienced by the spheroidal drop is numerically evaluated with adequate convergence behavior for various values of the internal-to-external viscosity ratio and axial- to-radial aspect ratio of the drop. The numerical values of the drag force for the infinite and infinitesimal viscosity ratios agree with the available corresponding results for the slow translation of a slip spheroidal particle in the limiting conditions of no slip and full slip, respectively.
3. Next, we examined the thermocapillary migration of a concentric compound drop in an arbitrary viscous flow under the consideration of negligible Reynolds number. The thermocapillary effect refers to the migration of a drop under the influence of a temperature gradient. The thermal field is governed by the heat conduction equation whereas the hydrodynamic fluid velocities are governed by the linearized Navier–Stokes equations. Presence of temperature gradient results in variation of the interfacial tension which is assumed to depend on temperature linearly. Variation of interfacial gradient leads to the coupling of the hydrodynamic problem with the thermal problem through the boundary condition. A complete general solution of Stokes equations is utilized to obtain closed-form expressions for the velocity vector and pressure. The hydrodynamic forces acting on the compound drop are obtained and expressed in terms of Faxén’s law which is further used to obtain the migration velocity of compound drop.
4. We have analyzed the problem of slow motion of a slightly deformed spherical drop in an arbitrary unsteady Stokes flow. Here, we have used method of regular perturbation expansion in terms of a small parameter also termed as deformation parameter that characterizes a slight deviation in shape of drop from spherical. We aimed to solve the problem only up to the first order of deformation parameter due to involvement of modified spherical Bessel function which makes the solution cumbersome at the second order problem.
5. Currently, we are investigating the thermocapillary migration of a slightly deformed drop in viscous flow. We plan to obtain the migration velocity up to the second order of deformation parameter. In this regard, a regular perturbation technique will be used to solve the thermal as well as the hydrodynamic problem.

PUBLICATIONS

Published

1. A. Basak, Jai Prakash, G. P. Raja Sekhar, Thermocapillary migration of a surfactant-laden droplet near a plane wall at low surface Péclet numbers, **International Journal of Multiphase Flow**, 195 (2026), 105534.

2. Ch. Dhanya, **Jai Prakash**, Huan J. Keh, Slow translation of a slightly deformed spherical fluid drop in an arbitrary unsteady viscous flow, **International Journal of Engineering Science**, 217 (2025), 104401.
3. **Jai Prakash**, Huan J. Keh, Thermocapillary motion of a spheroidal drop in an immiscible fluid, **International Journal of Multiphase Flow**, 184 (2025), 105072.
4. Ch. Dhanya, **Jai Prakash**, Thermocapillary migration of compound drop inside a spherical cavity, **ZAMP**, 75 (2024), 141.
5. Ch. Dhanya, **Jai Prakash**, Thermocapillary migration of compound drop in an arbitrary viscous flow, **European Journal of Mechanics B/ Fluids**, 106 (2024), 280-289.
6. **Jai Prakash**, Huan J. Keh, Translational motion of a spheroidal drop in a viscous fluid, **Physics of Fluids**, 36 (2024), 053101.
7. **Jai Prakash**, Huan J. Keh, Slow translation of a slightly deformed spherical fluid drop, **Physics of Fluids**, 35 (2023), 073105.
8. **Jai Prakash**, C. Satyanarayana, Axisymmetric Slow Motion of a Porous Spherical Particle in a Viscous Fluid Using Time Fractional Navier–Stokes Equation, **Colloids Interfaces** 2021, 5(2), 24.
9. **Jai Prakash**, Hydrodynamic mobility of a porous spherical particle with variable permeability in a spherical cavity, **Microsystem Technologies**, 26 (2020), 2601-2614.
10. **Jai Prakash**, G. P. Raja Sekhar, Effective viscosity of a concentrated suspension of composite porous spherical particles, **Meccanica**, 54 (2019), 799-813.
11. **Jai Prakash**, G. P. Raja Sekhar, Slow motion of a porous spherical particle with a rigid core in a spherical fluid cavity, **Meccanica**, 52 (2017), 92-105.
12. Olga M. Lavrenteva, **Jai Prakash**, Avinoam Nir, Effect of added mass on the interaction of bubbles in a low Reynolds number shear flow, **Physical Review E**, 93 (2016), 023105.
13. **Jai Prakash**, Olga M. Lavrenteva, & Avinoam Nir, Application of Clebsch variables to fluid-body interaction in presence of non-uniform vorticity, **Physics of Fluids**, 26 (2014), 077102.
14. **Jai Prakash**, Olga M. Lavrenteva, & Avinoam Nir, Interaction of bubbles in inviscid and low viscosity shear flow, **Physical Review E**, 88 (2013), 023021.
15. **Jai Prakash**, Olga M. Lavrenteva, Leonid Byk, & Avinoam Nir, Interaction of equal size bubbles in shear flow, **Physical Review E**, 87 (2013), 043002.
16. **Jai Prakash**, G. P. Raja Sekhar, Dynamic permeability of an assemblage of soft spherical particles, **Mathematical Methods in the Applied Sciences**, 36 (2013), 2174-2186.
17. **Jai Prakash**, G. P. Raja Sekhar, Estimation of dynamic permeability of an assembly of permeable spherical porous particles using the cell model, **Journal of Engineering Mathematics**, 80 (2013), 63-73.
18. **Jai Prakash**, G. P. Raja Sekhar, Arbitrary oscillatory Stokes flow past a porous sphere using Brinkman model, **Meccanica**, 47 (2012), 1079-1095.

19. **Jai Prakash**, G. P. Raja Sekhar, Mirela Kohr, Faxén's law for arbitrary oscillatory Stokes flow past a porous sphere, **Archives of Mechanics**, 64 (2012), 41-63.
20. **Jai Prakash**, G. P. Raja Sekhar, Sirshendu De, Convection–diffusion–reaction inside a permeable cylindrical porous pellet under oscillatory flow - the effect of Robin boundary condition, **International Journal of Advances in Engineering Sciences and Applied Mathematics**, 3(2011), 60-70.
21. **Jai Prakash**, G. P. Raja Sekhar, Mirela Kohr, Stokes flow of an assemblage of porous particles –stress jump condition, **ZAMP**, 62(2011), 1027-1046.
22. **Jai Prakash**, G. P. Raja Sekhar, Sirshendu De, Dirichlet problem for convection–diffusion–reaction inside a permeable cylindrical porous pellet, **International Journal of Engineering Science**, 49 (2011), 606-624.
23. **Jai Prakash**, Sirshendu De, G. P. Raja Sekhar, Convection–diffusion–reaction inside a porous sphere under oscillatory flow including external mass transfer, **Fluid Dynamics Research**, 43 (2011), 015508.
24. **Jai Prakash**, G. P. Raja Sekhar, Overall bed permeability for flow through beds of permeable porous particles using effective medium model-stress jump condition, **Chemical Engineering Communications**, 198 (2011), 85-101.
25. **Jai Prakash**, G. P. Raja Sekhar, Sirshendu De, Michael Böhm, Convection, diffusion and reaction inside a spherical porous pellet in presence of oscillatory flow, **European Journal of Mechanics B/ Fluids**, 29 (2010), 483-493.
26. **Jai Prakash**, G. P. Raja Sekhar, Sirshendu De, Michael Böhm, A criterion to avoid starvation zones for convection-diffusion-reaction problem inside a porous biological pellet under oscillatory flow, **International Journal of Engineering Science**, 48 (2010), 693-707.
27. Mirela Kohr, **Jai Prakash**, G. P. Raja Sekhar, and Wolfgang L Wendland, Expansions at small Reynolds numbers for the flow past a porous circular cylinder, **Applicable Analysis**, 88 (2009), 1093-1114.
28. G. P. Raja Sekhar, **Jai Prakash**, and Mirela Kohr, Steady and oscillatory analysis of porous catalysts in fluidized beds, **PAMM: Proc. Applied Mathematics and Mechanics**, 8 (2009), 10613-10614.

Under Review:

1. Electrophoresis of a slightly deformed spherical charged biocolloid in a gel-like medium.

Under Preparation

1. Creeping motion of a slightly deformed spherical drop with active slip.
1. Thermocapillary motion of a micropolar fluid drop in a viscous fluid.
2. Effect of interfacial viscosity on migration of a surfactant laden drop in unsteady Stokes flow.

CONFERENCE PAPERS

1. **Jai Prakash**, Kamalesh Acharya, and G. P. Raja Sekhar, Reflection theorem for Stokes flow in presence of a partial-slip interface, Proceedings of ISTAM 2011, 175-184.
2. **Jai Prakash**, G. P. Raja Sekhar, Motility of a cell in viscous fluid flow, Proceedings of ISTAM 2006, 31-35.

TALKS/ CONFERENCES/ RESOURCE PERSON

1. Delivered a technical talk titled "Translational motion of a slightly deformed viscous spherical droplet in Stokes flow" in ICIAM (2023) held at Waseda University Tokyo, Japan, August 20-25, 2023.
2. Delivered an invited talk in the workshop "Physics of Fluids - Methods and Applications" held at GITAM University, Hyderabad, June 19-21, 2023.
3. Acted as resource person for Refresher Course on Mathematics (RC-MATHEMATICS) held at University of North Bengal, January 2021.
4. Attended ATAL Faculty Development Program on "Cutting-edge multidisciplinary research in the field of fluids" held at NIT Rourkela, October 11-15, 2021.
5. Attended ATAL Faculty Development Program on "Mathematical Modelling for Problems in Coastal and Offshore Engineering" held at IIT Guwahati, September 14-18, 2020.
6. **Jai Prakash**, Fluid - body interaction in presence of non-uniform vorticity, IIT Bhubaneswar, October 2019.
7. **Jai Prakash**, Interaction of monosize bubbles in shear flow, NIT Allahabad, May 2019.
8. **Jai Prakash**, Fluid - body interaction in presence of non-uniform vorticity, IIT Ropar, November 2018.
9. **Jai Prakash**, Formation of a stable ring of bubbles in a Couette device with Taylor vortices, IIT Patna, March 2014.
10. **Jai Prakash**, Formation of a stable ring of bubbles in a Couette device with Taylor vortices, IIT Kharagpur, March 2014.
11. **Jai Prakash**, Formation of a stable ring of bubbles in a Couette device with Taylor vortices. Latest Advances in Computational and Applied Mathematics (LACAM), December 15 -17, 2016, Mahindra École Centrale, Hyderabad.
12. **Jai Prakash**, Olga M. Lavrenteva & Avinoam Nir, The formation of a stable ring of bubbles in a Couette device with Taylor vortices, The 2012 ISIMM SYMPOSIUM - STAMM XVIII (3rd – 6th September 2012), Technion, Israel.

13. **Jai Prakash**, G. P. Raja Sekhar, and Sirshendu De, convection–diffusion–reaction inside a permeable cylindrical porous pellet–Robin problem, National Institute of Technology Hamirpur, India, 55th Congress of ISTAM–Indian Society of Theoretical and Applied Mechanics (An International Meet) (18th – 21st December 2010).
14. **Jai Prakash**, G. P. Raja Sekhar, and Sirshendu De, Analysis of nutrient transport inside spherical porous biological pellets in oscillatory flow, University College of Engineering, Osmania University, Hyderabad, India, 53rd Congress of ISTAM (27th – 30th December 2008).
15. **Jai Prakash**, G. P. Raja Sekhar, Oscillatory Stokes flow past a porous sphere, BNM Institute of Technology, Bangalore, India, 52nd Congress of ISTAM (14th – 17th December 2007).
16. **Jai Prakash**, G. P. Raja Sekhar, Motility of a cell in viscous fluid flow, Andhra University College of Engineering, Visakhapatnam, India, 51st Congress of ISTAM (18th – 21st December 2006).

Research Collaboration

1. **Prof. Huan J. Keh**
Department of Chemical Engineering
National Taiwan University
Taipei-10167, Taiwan
2. **Prof. G. P. Raja Sekhar**
Department of Mathematics
Indian Institute of Technology Kharagpur
Kharagpur-721302, India
3. **Dr. Bibaswan Dey**
Department of Mathematics
University of North Bengal
Darjeeling, India

TEACHING EXPERIENCE

Sl. No.	Title of course taught	Postgraduate/ Undergraduate	Course Coordinator
1.	Math I and Math II at IIT Kharagpur	Undergraduate	Tutor
2.	Calculus and Ordinary Differential Equations	Undergraduate	Yes
3.	Linear Algebra and Applied Analysis	Undergraduate	Yes
4.	Computational Methods and Scientific Computing	Undergraduate	No
5.	Complex Analysis and Integral Transform	Undergraduate	Yes
6.	Computational Methods for PDE	Undergraduate	Yes
7.	Calculus of Variations and Integral Equations	Undergraduate	Yes
8.	Mathematical Methods	Undergraduate	Yes
9.	Dynamical Systems	Undergraduate	Yes
10.	Magnetohydrodynamics	Postgraduate	Yes
11.	Numerical Analysis	Postgraduate	No
12.	Advanced Differential Equations	Pre Ph.D.	Yes

SERVICE

- PG Coordinator, Department of Mathematics, Mahindra university, Hyderabad.
- Doctoral Research Committee (DRC) member for department of Chemistry and Mathematics.
- Internal Research Committee (IRC) member at Mahindra University.
- DQC committee member at department of Mathematics, BHU since 21-11-2024.
- SWAYAM course coordination committee member at department of Mathematics, BHU since 16-04-2025.
- Doctoral Advisory Committee (DAC) member for K. Rakshana, PhD student at VIT Vellore.
- Chaired a technical session at ICIAM (2023), Waseda University, Tokyo, Japan.
- Department PG admission committee member, BHU
- Organized National Mathematics Day Symposium on December 23, 2024, Department of Mathematics, BHU
- Reviewer (Journals): Microsystem Technologies, Modelling and Simulation in Engineering, Journal of Engineering Mathematics, European Journal of Mechanics B/Fluids, Transport in Porous Media, Physics of Fluids, ZAMM, Fluid Dynamics Research, The European Physical Journal Special Topics.

HONORS AND AWARDS

1. PBC Post Doctoral Fellowship of Israel, 2012.

2. NBHM Post Doctoral Fellowship (December, 2010).
3. Senior Research Fellowship in Mathematical Sciences from Council of Scientific and Industrial Research (CSIR), India (August 2007–July 2010).
4. Junior Research Fellowship in Mathematical Sciences from Council of Scientific and Industrial Research (CSIR), India (August 2005–July 2007).
5. Qualified Graduate Aptitude Test in Engineering (GATE) in Mathematics (2005) AIR–184.
6. TECHNICAL SKILLS

- **Operating Systems:** Windows, Linux
- **Applications:** Latex, Matlab, Mathematica, Maple, Origin, MS Office.

REFERENCES

1. **Prof. G. P. Raja Sekhar**
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4. **Prof. B.S. Padmavati**
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