

# Rishabh P. Sharma

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## RESEARCH INTERESTS

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Self-organization, Pattern formation, Growth processes, Fluid dynamics, Porous medium, Multiphase flows, Soft-matter physics

## EDUCATION

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2020 – present **University of Warsaw, Poland**

Ph.D. in Physics; *Advisors:* Prof. Piotr Szymczak and Prof. Mariusz Białecki

Title: **Self-organization of flow in dissolving rocks**

I have developed an integrated approach that combines theoretical and computational modelling with 4D X-ray images of a porous rock to study dissolution patterns in rock samples. I have also developed image analysis tools to extract the structure of the dissolution patterns from dissolution experiments.

2015 – 2017 **Thapar University, India**

M.E. in Thermal Engineering; *Advisor:* Prof. Neeraj Kumar

Title: **Nodal integral method for convection-diffusion transport in complex domain using linear and higher order quadrilateral elements**

2010 – 2014 **Uttar Pradesh Technical University, India**

B.Tech. in Mechanical Engineering

## RESEARCH EXPERIENCE

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2021 – 2024 **Research team member, Faculty of Physics, University of Warsaw** in a project, developing computational models to study dissolution patterns in unsaturated medium

2018 – 2021 **Research team member, Institute of Geophysics, Polish Academy of Sciences,** in a project modelling dissolution patterns in saturated medium with Darcy models media

Feb-Oct, 2018 **Project Tech. Asst., Dept. of Energy Sciences. IIT Bombay** in a project modelling the propagation of non-linear ultrasonic waves in a tumour

2017 – 2018 **Project Res. Assc., Dept. of Aerospace Engg., IIT Bombay** in a project investigating particulate flows using CFD-DEM modelling approach

## AWARDS/FUNDING

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2024 IDUB University research microgrant to attend a physics school

2024 IDUB University support for completion of doctoral dissertation

2023 IDUB University research microgrant to attend a physics school

2023 Early Career Scientist's Travel Support Award by European Geophysical Union

2022 Uni. Integrated Development Programme (ZIP) travel support for a research visit

2021– Scientific scholarship in a project funded by National Science Centre

2020– Interdisciplinary doctoral school scholarship

2020 SEG Student Chapter, Field Camp-2020, IGF-PAN

2018 Scientific scholarship in a project funded by National Science Centre

2015 Graduate Scholarship, Ministry of Education, Government of India

2010 University Scholarship for Merit-Incentive Students

2010 Bronze Medal in Programming Diploma by NCVT, Government of India

2006 11<sup>th</sup> position in Pioneer 7<sup>th</sup> science competition

## JOURNAL ARTICLES

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1. Cooper, M. P., **Sharma, R. P.**, S. Magni, T. P. Blach, A. P. Radlinski, K. Drabik, A. Tengattini, and P. Szymczak (May 2023). 4D tomography reveals a complex relationship between wormhole advancement and permeability variation in dissolving rocks. *Advances in Water Resources* **175**, 104407.
2. **Sharma, R. P.**, M. Bialecki, M. P. Cooper, A. P. Radliński, and P. Szymczak (June 2023). Pore merging and flow focusing: Comparative study of undissolved and karstified limestone based on microtomography. *Chemical Geology* **627**, 121397.
3. **Sharma, R. P.**, J. Deng, P. K. Kang, and P. Szymczak (Oct. 2023b). Effects of Mixing at Pore Intersections on Large-Scale Dissolution Patterns and Solute Transport. *Geophysical Research Letters* **50**(21).
4. **Sharma, R. P.** and N. Kumar (2018b). Nodal integral method for convection-diffusion transport using linear and higher order quadrilateral elements. *Numerical Heat Transfer, Part B: Fundamentals* **74**(3), 623–645.

## CONFERENCE PROCEEDINGS

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1. **Sharma, R. P.** and N. Kumar (2018a). Nodal integral method for complex geometries using higher order elements. In: *Proceedings of the 24th National and 2nd International ISHMT-ASTFE Heat and Mass Transfer Conference (IHMTTC-2017)*. Begellhouse.

## CONFERENCE PRESENTATIONS

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1. Dzikowski, M., P. Szymczak, and **Sharma, R. P.** (2023). Empowering pre-exascale computers for Darcy-Brinkman simulation of wormhole growth based on X-CT data-can we recover experiments? In: EGU23-739.
2. **Sharma, R. P.**, P. K. Kang, and P. Szymczak (May 2023). Effects of mixing at pore intersections on large-scale dissolution patterns. In: *EGU General Assembly 2023, Vienna, Austria*, EGU-275, pp. EGU-275.
3. Bialecki, M., **Sharma, R. P.**, M. P. Cooper, and P. Szymczak (May 2022). Comparative study of undissolved and karstified limestone based on microtomography. In: *EGU General Assembly 2022, Vienna, Austria*, EGU22-5229, pp. EGU22-5229.
4. Lipar, M., P. Szymczak, R. Ciglič, **Sharma, R. P.**, M. Zorn, U. Stepišnik, and M. Ferik (May 2022). Challenges in characterisation and mapping of solution pipes. In: *EGU General Assembly 2022, Vienna, Austria*, EGU22-1619, pp. EGU22-1619.
5. **Sharma, R. P.** and P. Szymczak (2021). “Network modelling of wormholing process in rocks”. DREAMS21 Workshop, University of Paris Diderot, Laboratoire Matière et Systèmes Complexe.
6. Szymczak, P., M. P. Cooper, S. Magni, **Sharma, R. P.**, T. P. Blach, A. P. Radlinski, M. Dohnalik, and A. Tengattini (Apr. 2021). Wormhole Growth in Dissolving Limestones: Insights from 4D Tomography. In: *EGU General Assembly 2021, Vienna, Austria*, EGU21-13883, pp. EGU21-13883.
7. **Sharma, R. P.**, M. Cooper, A. J. C. Ladd, and P. Szymczak (2020). “Flowfield study in dissolved porous media”. University of Wrocław, Institute of Theoretical Physics CFD Wrocław-7 workshop, Wrocław, Poland.
8. Szymczak, P., M. P. Cooper, S. Magni, **Sharma, R. P.**, T. P. Blach, A. P. Radlinski, M. Dohnalik, and A. Tengattini (Dec. 2020). Combined Neutron and X-ray Time-Resolved Tomography of Wormhole Growth in Dissolving Limestones. In: *AGU Fall Meeting*. Vol. 2020, H081-01, pp. H081-01.

## POSTERS

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1. **Sharma, R. P.**, J. Deng, P. K. Kang, and P. Szymczak (2024). “Effects of mixing at pore intersections on large-scale dissolution patterns and solute transport”. 6<sup>th</sup> Cargese summer school: FLOW and Transport in porous and fractured Media (FLOWTIME), Cargese, France.
2. Deng, J., **Sharma, R. P.**, P. Szymczak, and P. K. Kang (Dec. 2023). Anomalous Transport through Dissolving Fracture Networks. In: *AGU Fall Meeting 2023, San Francisco, CA*. Vol. 2023, H12D-04, pp. H12D-04.
3. Dzikowski, M., **Sharma, R. P.**, and P. Szymczak (2023). “High-resolution Darcy-Brinkman simulation of wormhole growth based on X-CT data”. InterPore-2023, Edinburg, Scotland.
4. **Sharma, R. P.**, M. Bialecki, and P. Szymczak (2023). “How does chemical erosion change the pore structure of a rock?” Geilo School 2022-The Physics of Evolving Matter: Memory, Learning and Evolution, Geilo, Norway.
5. **Sharma, R. P.**, M. Cooper, and P. Szymczak (2023). “Geometric measures of wormholes in dissolving rocks”. Geilo School 2023-The Physics of Evolving Matter Continued: Connectivity, Communication and Growth, Geilo, Norway.

6. Cooper, M. P., **Sharma, R. P.**, S. Magni, P. N. H. Vu, T. Ladd, A. P. Radlinski, T. P. Blach, K. Drabik, A. Tengattini, and P. Szymczak (Dec. 2022). Competition Between Wormholes in Dissolving Rocks Captured with 4D Tomography and Numerical models. In: *AGU Fall Meeting*. Vol. 2022, H52N-0635, pp.H52N-0635.
7. Dzikowski, M., P. Szymczak, and **Sharma, R. P.** (Dec. 2022). Large Scale Simulations of Wormhole Growth in Dissolving Porous Media using Lattice Boltzmann Method. In: *AGU Fall Meeting*. Vol. 2022, H52N-0644, pp.H52N-0644.
8. **Sharma, R. P.**, P. K. Kang, and P. Szymczak (2022). "The impact of intersection mixing rules on the network-scale dissolution patterns". 7<sup>th</sup> Warsaw School of Statistical Physics, Sandomierz, Poland.
9. **Sharma, R. P.**, M. P. Cooper, A. J. C. Ladd, and P. Szymczak (Apr. 2021). Subpixel determination of wormhole tip position in 4D tomography of dissolving limestone cores. In: *EGU General Assembly 2021, Vienna, Austria*, EGU21-14962, pp. EGU21-14962.
10. **Sharma, R. P.**, M. P. Cooper, A. J. C. Ladd, and P. Szymczak (May 2020). Modeling wormhole formation in digital rock samples: the role of segmentation and permeability-porosity relationships. In: *EGU General Assembly 2020, Vienna, Austria*. EGU General Assembly Conference, 996, pp.996.
11. Cooper, M. P., S. Magni, **Sharma, R. P.**, P. N. Vu, T. P. Blach, A. P. Radlinski, M. Dohnalik, A. Tengattini, A. Ladd, and P. Szymczak (2019). Determining the influence of pore-scale geometry on wormhole formation. In: *AGU Fall Meeting*. Vol. 2019, pp.H21M-1931.

## TALKS/SEMINARS

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1. **Sharma, R. P.**, M. Cooper, and P. Szymczak (2021a). "Fractal shapes in dissolving rocks". Symposium of young scientist (SMN2021), University of Warsaw.
2. **Sharma, R. P.**, M. Cooper, and P. Szymczak (2021b). "Study of dissolution channels and their geometrical properties using XCMT images". Looping Network Meeting, University of Paris Diderot, Paris, France.
3. **Sharma, R. P.**, M. Cooper, and P. Szymczak (2021c). "Study of geometrical measures of wormholes using 4D-tomography". University of Warsaw, Department of Complex Modelling Complex system seminar, Nov-2021.
4. **Sharma, R. P.**, M. Cooper, and P. Szymczak (2021d). "Study of geometrical measures of wormholes using 4D-tomography". University of Warsaw, Faculty of Physics Soft matter and statistical Physics seminar, Nov-2021.

## TECHNICAL SKILLS

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**Programming Languages:** C, C++, Python, Fortran

**Computing:** OpenFOAM, Matlab, Mathematica

## TEACHING

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### Graduate Teaching Assistant

Fall, 2023 Hydrodynamics and Elasticity  
 Spring, 2022 Geophysical Laboratory-II

### Student Team Project Supervisor

Spring, 2022 Study of the hydrodynamic properties of a mixture of ground coffee and water  
 Spring, 2024 Introduction to OpenFOAM

## REFERENCES

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Prof. Piotr Szymczak  
Professor  
Institute of Theoretical Physics  
University of Warsaw, Poland  
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Prof. Mariusz Białecki  
Associate Professor  
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