

HARSHA S. BHAT

CNRS Director of Research & Teaching Professor

Laboratoire de Géologie

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PSL



EDUCATION

École Normale Supérieure, France

Harvard University, USA

Harvard University, USA

NITK, India

H. D. R.[†] Supershear Earthquakes 2021/01

Ph. D.* Mechanical Sciences 2007/06

M. S. Engineering Sciences 2002/06

B. E. Civil Engineering 2001/06

[†] Habilitation à Diriger des Recherches * Supervised by Prof. J. R. Rice & Dr. R. Dmowska

CURRENT POSITION

École Normale Supérieure, France

2024/10 ► Present CNRS Director of Research

Ecole Polytechnique, France

2022/09 ► Present Teaching Professor (PCC)

PAST POSITIONS

École Normale Supérieure, France

2016/05 ► 2024/09 CNRS Research Scientist

NISER, India

2021/11 ► 2023/11 Visiting Professor

Institut de Physique du Globe de Paris, France

2012/01 ► 2016/05 CNRS Research Scientist

University of Southern California, USA

2010/03 ► 2011/12 Asst. Professor (Research)

University of Southern California, USA

2007/11 ► 2010/03 Post Doctoral Fellow

California Institute of Technology, USA

2007/11 ► 2010/03 Visitor in Aeronautics

Harvard University, USA

2007/05 ► 2007/10 Post Doctoral Fellow

Harvard University, USA

2001/11 ► 2007/05 Grad. Research Associate

FUNDING & GRANTS[†]

- 2021-2025 ► 2M€ ERC Consolidator Grant, PERSISMO (Grant No. 865411)
- 2018-2018 ► 25k€ ENS Actions Incitatives
- 2017-2017 ► 6k€ TelluS INSU - action ALEAS
- 2023-2027 ► 100k€ ANR SMEC
- 2023-2026 ► 100k€ ANR Univ. Tokyo SESAME
- 2023-2025 ► 66k€ SPARC Grant India

HONORS AND AWARDS

- 2018 CNRS Award for Doctoral Supervision and Research
- 2018 Grand Prix Michel Gouilloud Schlumberger, French Academy of Sciences
- 2006 Harvard University Certificate of Distinction in Teaching
- 2004 Harvard University Certificate of Distinction in Teaching
- 2003 Harvard University Certificate of Distinction in Teaching

CURRENT TEACHING RESPONSIBILITIES AT ÉCOLE POLYTECHNIQUE[†]

MEC430 Mécanique du Milieu continu 1: Contrôle Correction (Fall 2024)

MEC431 Mécanique des Solides: PC sections (Spring 2023)
 MEC568 Mécanique de la Rupture: PC sections (Spring 2023, 2024)
 MEC592 Mécanique des matériaux et des structures: Internships (Spring 2024)

STUDENTS & POSTDOCS

A majority of the people below were/are being co-advised/co-supervised with colleagues from various institutes in EU, USA and France.

Postdoctoral Associates

Ankit Gupta (India)	2024-	
Navid Kheirdast (Iran)	2022-	
Michelle Almakari (France)	2021-2023	
Carlos Villafuerte (Mexico)	2021-2023	Asst. Prof. UNAM
Ekeabino Momoh (Nigeria)	2019-2022	AXA Postdoc Fellow
Lucile Bruhat (France)	2018-2021	Natural Catastrophe Risk Analyst at AXA
Lisa Gordeliy (Russia)	2019-2019	Post Doctoral fellow at Ecole Polytechnique
Marion Y. Thomas (France)	2014-2016	CNRS Scientist at Sorbonne Université

PhD Students

Bharath Shanmugasundaram (India)	2024-2027	
Yishuo Zhou (China)	2024-2027	
Thomas Melkior (France)	2023-2026	
Caiyuan Fan (China)	2023-2027	
Jinhui Cheng (China)	2021-2024	Postdoc Caltech
Augustin Thomas (France)	2020-2023	Postdoc BRGM
Joseph Flores Cuba (Peru)	2020-2023	
Claudia Hulbert (France)	2018-2021	CEO Geolabe
Samson Marty (France)	2017-2020	Postdoc at Caltech
Marshall A. Martinez (USA)	2014-2019	Engineer at Joby Aviation
Kurama Okubo (Japan)	2015-2018	Research Scientist at NIED, Japan
Pierre Romanet (France)	2014-2017	Research Scientist at NIED, Japan
Vahe Gabuchian (USA)	2010-2015	Research Scientist at Caltech
François X. Passelègue (France)	2011-2014	CNRS Scientist at GeoAzur, Nice
Jonathan Mihaly (USA)	2008-2013	Jet Propulsion Laboratory
Michael Mello (USA)	2007-2012	Teaching Professor at Caltech

Undergraduate and Masters Interns

Valentin Marnat	2022	Phillipe Danre	2017
Roxane Ferry	2021	Eleni Kolokytha	2015
Jinhui Cheng	2020	Victor Barolle	2015
Phillipe Danre	2019	Kurama Okubo	2014
Roxane Ferry	2019	Thibaut Perol	2013
Hugo Lestrelin	2019	Lucile Bruhat	2012
Nicolas Mercury	2018	Marion Olives	2004
Luc Illien	2018	Sonia Fliss	2003

PAST TEACHING ACTIVITIES†

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|--|---|
| 1) Mécanique des Milieux Continus | 8) Complex and Fourier Analysis |
| 2) Active Faults : Geometry | 9) Computational Solid and Structural Mechanics |
| 3) Seismic Ruptures and Scaling Laws | 10) Solid Mechanics |
| 4) Introduction to Rock Physics | 11) Introduction to the Mechanics of Solids |
| 5) Mathematical Methods in the Sciences | 12) Mechanics of Fracture |
| 6) Environmental Risks and Disasters | 13) Advanced Geomechanics |
| 7) Ordinary and Partial Differential Equations | 14) Mécanique de la Fracturation |

ORGANIZATION OF SCIENTIFIC MEETINGS

- Apr 2024: Across the time scales, from earthquakes to earthquake cycle: EGU 2024
- Apr 2023: Across the time scales, from earthquakes to earthquake cycle: EGU 2023
- Jun 2019: Coupled Processes In Fracture Propagation In Geo-Materials: From Hydraulic Fractures To Earthquakes: CISM Advanced School, Udine, Italy
- Apr 2015: Seismological Society of America, Multiscale Modeling and Characterization of Fragmentation and Damage Patterns in Fault Zones
- Dec 2014: American Geophysical Union, Fault Zone Properties And Processes During Dynamic Ruptures

INSTITUTIONAL RESPONSIBILITIES

- 2018-2024: Team Leader of Faults & Earthquakes Group, ENS
- 2018-2019: Co-organizer of the Internal Seminar, ENS

EDITORIAL RESPONSIBILITIES

Member of the Editorial Board for the **Journal of Theoretical Computational and Applied Mechanics**

REVIEWING ACTIVITIES

American Geophysical Union Seismological Society of America International Journal of Fracture Geological Society of America Science Nature Journal of the Mechanics and Physics of Solids European Journal of Mechanics - A/Solids Earth and Planetary Science Letters Geophysical Research Letters Journal of Structural Geology Proceedings of the National Academies of Science, USA Geology Geophysical Journal International Journal of Applied Mechanics National Science Foundation European Research Council Nature Communications Nature Geoscience Science Advances

BOOKS

Thomas, Marion Y., Mitchell, Thomas M., and Bhat, H. S., eds. (2017b). "*Fault Zone Dynamic Processes : Evolution of Fault Properties During Seismic Rupture, Geophysical Monograph 227*". American Geophysical Union (AGU). DOI: 10.1002/9781119156895.

Bizzarri, A. and Bhat, H. S., eds. (2012). "*The mechanics of faulting: From laboratory to earthquakes*". Research Signpost.

BOOK CHAPTERS

Thomas, Marion Y. and Bhat, Harsha S. (2022b). "*Loi de friction et modélisation numérique du cycle sismique*". in *Le Cycle Sismique*. Ed. by Frédérique Rolandone. ISTE-Wiley.

Thomas, Marion Y. and Bhat, Harsha S. (2022a). "*Friction Laws and Numerical Modeling of the Seismic Cycle*". in *The Seismic Cycle: From Observation to Modeling*. Ed. by Frédérique Rolandone. ISTE-Wiley.

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To be submitted

Cheng, Jinhui, Almakari, Michelle, Peruzzo, C., Lecampion, B., and Bhat, H. S. (2024b). "*The effect of 3D fault interactions on slow and fast earthquakes*". [to be submitted for GRL](#).

- Cheng, Jinhui, Almakari, Michelle, Peruzzo, C., Lecampion, B., and Bhat, H. S. (2024a). “*FASTDASH, a Quasi-dynamic 3D Seismic Cycle Model by Using Boundary Element Method with H-matrices*”. [to be submitted for GJI](#).
- Thomas, Marion Y, Bhat, H. S., and Dubernet, Pierpaolo (2024b). “*Combined effects of fault roughness and off-fault damage on earthquake dynamics*”. [to be submitted](#).
- Almakari, Michelle, Kheirdast, N., Villafuerte, C. D., Thomas, M. Y., Bhat, H. S., Cheng, Jinhui, and Dubernet, Pierpaolo (2024). “*Full spectrum of slip dynamics of a fault zone: Source Dynamics*”. [to be submitted](#).
- Villafuerte, C. D., Almakari, Michelle, Kheirdast, N., Thomas, M. Y., Bhat, H. S., Cheng, Jinhui, and Dubernet, Pierpaolo (2024). “*Full spectrum of slip dynamics of a fault zone: Synthetics*”. [to be submitted](#).
- Kheirdast, N., Almakari, Michelle, Villafuerte, C. D., Bhat, H. S., Cheng, Jinhui, and Dubernet, Pierpaolo (2024). “*Full spectrum of slip dynamics of a fault zone: Energy Budget*”. [to be submitted](#).
- Flores-Cuba, J., Thomas, M. Y., Bhat, H. S., Jolivet, L., and Dubernet, Pierpaolo (2024). “*Effect on off-fault damage on stepovers*”. [in prep](#).
- Thomas, M. Y., Preca Trapani, Rachel, Bhat, Harsha S., Klinger, Y., and Dubernet, Pierpaolo (2024a). “*Investigating the Impact of Complex Fault Zone Geometries on Seismic Rupture Propagation*”. [to be submitted](#).
- Published**
- Momoh, E., Bhat, H. S., Tait, S., and Gerbault, M. (2025). “*Volumetric (dilatant) plasticity in geodynamic models and implications on thermal dissipation and strain localization*”. [to appear in Geophys. J. Int.](#)
- Ferry, Roxane, Thomas, M. Y., Bhat, H. S., and Dubernet, Pierpaolo (2025). “*Depth Dependence of Coseismic Off-Fault Damage and its Effects on Rupture Dynamics*”. [J. Geophys. Res.](#) e2024JB029787. DOI: 10.1029/2024JB029787.
- Petit, Léo, Olive, J-A, Schubnel, Alexandre, Le Pourhiet, L., and Bhat, H. S. (2024). “*A brittle constitutive law for long-term tectonic modeling based on sub-critical crack growth*”. [to appear in Geochem. Geophys. Geosyst.](#) 25, e2023GC011229. DOI: 10.1029/2023GC011229.
- Jeandet-Ribes, L., Thomas, M. Y., and Bhat, H. S. (2023). “*On the importance of setting 3-D stress field in simulations of on- and off-fault deformation*”. [Geophys. J. Int.](#) 235.3, pp. 2962–2978. DOI: 10.1093/gji/ggad401.
- Marty, S., Schubnel, A., Bhat, H. S., Aubry, J., Fukuyama, E., Latour, S., Nielsen, S., and Madariaga, R. (2023). “*Nucleation of laboratory earthquakes: quantitative analysis and scalings*”. [J. Geophys. Res.](#) 128.e2022JB026294. DOI: 10.1029/2022JB026294.
- Amlani, Faisal, Bhat, Harsha S., Simons, Wim J. F., Schubnel, Alexandre, Vigny, Christophe, Rosakis, Ares J., Efendi, Joni, Elbanna, Ahmed, Dubernet, Pierpaolo, and Abidin, Hasanuddin Z. (2022). “*Supershear shock front contribution to the tsunami from the 2018 Mw 7.5 Palu, Indonesia earthquake*”. [Geophys. J. Int.](#) 230, pp. 2089–2097. DOI: 10.1093/gji/ggac162.
- Jara, Jorge, Bruhat, Lucile, Thomas, M. Y., Antoine, S., Okubo, K., Klinger, Y., Jolivet, Romain, and Bhat, H. S. (2021). “*Signature of transition to supershear rupture speed in coseismic off-fault damage zone*”. [Proc. R. Soc. A.](#) 477, p. 20210364. DOI: 10.1098/rspa.2021.0364.
- Elbanna, Ahmed, Abdelmeguid, Mohamed, Ma, Xiao, Amlani, Faisal, Bhat, Harsha S., Synolakis, Costas, and Rosakis, Ares J. (2021). “*Anatomy of Strike Slip Fault Tsunami Genesis*”. [Proc. Natl. Acad. Sci. USA.](#) DOI: 10.1073/pnas.2025632118.

- Bhat, H. S. (2021). *"Supershear Earthquakes"*. PhD thesis. Habilitation à Diriger des Recherches, Ecole Normale Supérieure.
- Jeandet-Ribes, Louise, Cubas, Nadaya, Bhat, Harsha S., and Steer, Philippe (2020). *"Response of a single fault to transient normal stress change, and implications of large erosional events on the seismic cycle"*. *Geophys. Res. Lett.* 47.e2020GL087631. DOI: 10.1029/2020GL087631.
- Jolivet, R, Simons, M, Duputel, Z, Olive, J-A, Bhat, H S, and Bletery, Quentin (2020). *"Interseismic Loading of Subduction Megathrust Drives Long-Term Uplift in Northern Chile"*. *Geophys. Res. Lett.* 47.8, e2019GL085377. DOI: 10.1029/2019GL085377.
- Okubo, K., Rougier, E, Lei, Z., and Bhat, H. S. (2020). *"Modeling earthquakes with off-fault damage using the combined finite discrete element method"*. *J. Comp. Part. Mech.* DOI: 10.1007/s40571-020-00335-4.
- Okubo, K., Bhat, H. S., Rougier, E., Marty, S., Schubnel, A., Lei, Z., Knight, E. E., and Klinger, Y. (2019). *"Dynamics, radiation and overall energy budget of earthquake rupture with coseismic off-fault damage"*. *J. Geophys. Res.* 124. DOI: 10.1029/2019JB017304.
- Marty, S., Passelègue, François X., Aubry, J., Schubnel, A., Bhat, Harsha S., and Madariaga, R. (2019). *"Origin of high-frequency radiation during laboratory earthquakes"*. *Geophys. Res. Lett.* 46. DOI: 10.1029/2018GL080519.
- Aubry, J., Passelègue, François X., Deldicque, D., Girault, F., Marty, S., Lahfid, A., Bhat, H. S., Escartin, J., and Schubnel, A. (2018). *"Frictional heating processes and energy budget during laboratory earthquakes"*. *Geophys. Res. Lett.* 45. DOI: 10.1029/2018GL079263.
- Klinger, Y. et al. (2018). *"Earthquake damage patterns resolve complex rupture processes"*. *Geophys. Res. Lett.* DOI: 10.1029/2018GL078842.
- Cruz-Atienza, V. M., Villafuerte, C. D., and Bhat, H. S. (2018). *"Rapid tremor migration and pore-pressure waves in subduction zones"*. *Nat. Commun.* 9.1, p. 2900. DOI: 10.1038/s41467-018-05150-3.
- Thomas, Marion Y and Bhat, Harsha S (2018). *"Dynamic evolution of off-fault medium during an earthquake: a micromechanics based model"*. *Geophys. J. Int.* 214.2, pp. 1267–1280. DOI: 10.1093/gji/ggy129.
- Romanet, Pierre, Bhat, H. S., Jolivet, Romain, and Madariaga, Raül (2018). *"Fast and slow earthquakes emerge due to fault geometrical complexity"*. *Geophys. Res. Lett.* DOI: 10.1029/2018GL077579.
- Gabuchian, Vahe, Rosakis, A. J, Bhat, H. S., Madariaga, Raül, and Kanamori, Hiroo (2017). *"Experimental evidence that thrust earthquake ruptures might open faults"*. *Nature* 545.336–339. DOI: 10.1038/nature22045.
- Thomas, M. Y., Bhat, H. S., and Klinger, Yann (2017a). *"Effect of Brittle off-fault Damage on Earthquake Rupture Dynamics"*. in *Fault Zone Dynamic Processes : Evolution of Fault Properties During Seismic Rupture, Geophysical Monograph 227*. Ed. by M. Y. Thomas, H. S. Bhat, and T. M. Mitchell. American Geophysical Union (AGU), pp. 255–280. DOI: 10.1002/9781119156895.ch14.
- Passelègue, François X., Latour, Soumaya, Schubnel, Alexandre, Nielsen, Stefan, Bhat, Harsha S., and Madariaga, Raül (2017). *"Precursory Processes during Laboratory Earthquakes"*. in *Fault Zone Dynamic Processes : Evolution of Fault Properties During Seismic Rupture, Geophysical Monograph 227*. Ed. by M. Y. Thomas, H. S. Bhat, and T. M. Mitchell. American Geophysical Union (AGU). Chap. 12, pp. 229–242. DOI: 10.1002/9781119156895.ch12.
- Perol, T. and Bhat, H. S. (2016). *"Micromechanics based permeability evolution in brittle materials at high strain rates"*. *Pure Appl. Geophys.* Pp. 1–12. DOI: 10.1007/s00024-016-1354-4.

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- Vallage, A, Klinger, Y, Grandin, R, Bhat, H. S., and Pierrot-Deseilligny, M (2015). “*Inelastic surface deformation during the 2013 Mw 7.7 Balochistan, Pakistan, earthquake*”. *Geology* 43.12, pp. 1079–1082. DOI: 10.1130/G37290.1.
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- Siriki, H., Bhat, H. S., Lu, X., and Krishnan, S. (2015). “*A Laboratory Earthquake-Based Stochastic Seismic Source Generation Algorithm for Strike-Slip Faults*”. *Bull. Seism. Soc. Am.* 105.4, pp. 2250–2273. DOI: 10.1785/0120140110.
- Mello, M., Bhat, H. S., Rosakis, A. J., and Kanamori, H. (2014). “*Reproducing The Supershear Portion Of The 2002 Denali Earthquake Rupture In Laboratory*”. *Earth Planet. Sc. Lett.* 387, pp. 89–96. DOI: 10.1016/j.epsl.2013.11.030.
- Passelègue, François X., Schubnel, Alexandre, Nielsen, Stefan, Bhat, Harsha S., and Madariaga, Raül (2013). “*From Sub-Rayleigh to Supershear Ruptures During Stick-Slip Experiments on Crustal Rocks*”. *Science* 340.6137, pp. 1208–1211. DOI: 10.1126/science.1235637.
- Bhat, H. S., Rosakis, A. J., and Sammis, C. G. (2012). “*A Micromechanics Based Constitutive Model For Brittle Failure at High Strain Rates*”. *J. Appl. Mech.* 79.3. DOI: 10.1115/1.4005897.
- Bhat, H. S., Sammis, C. G., and Rosakis, A. J. (2011). “*The Micromechanics of Westerley Granite at Large Compressive Loads*”. *Pure Appl. Geophys.* 168.12, pp. 1–18. DOI: 10.1007/s00024-011-0271-9.
- Bhat, H. S., Biegel, R. L., Rosakis, A. J., and Sammis, C. G (2010). “*The Effect of Asymmetric Damage on Dynamic Shear Rupture Propagation II: With Mismatch in Bulk Elasticity*”. *Tectonophysics* 493.3, pp. 263–271. DOI: 10.1016/j.tecto.2010.03.016.
- Biegel, R. L., Bhat, H. S., Sammis, C. G., and Rosakis, A. J. (2010). “*The Effect of Asymmetric Damage on Dynamic Shear Rupture Propagation I: No Mismatch in Bulk Elasticity*”. *Tectonophysics* 493.3, pp. 254–262. DOI: 10.1016/j.tecto.2010.03.020.
- Mello, M., Bhat, H. S., Rosakis, A. J., and Kanamori, H. (2010). “*Identifying the unique ground motion signatures of supershear earthquakes: Theory and experiments*”. *Tectonophysics* 493, pp. 297–326. DOI: 10.1016/j.tecto.2010.07.003.
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- Harris, R. A. et al. (2009). “*The SCEC/USGS dynamic earthquake rupture code verification exercise*”. *Seismol. Res. Lett.* 80.1. DOI: 10.1785/gssr1.80.1.119.
- Sammis, C. G., Rosakis, A. J., and Bhat, H. S. (2009). “*Effects of Off-fault Damage on Earthquake Rupture Propagation: Experimental Studies*”. *Pure Appl. Geophys.* 166. DOI: 10.1007/s00024-009-0512-3.

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- Dunham, E. M. and Bhat, H. S. (2008). "Attenuation of radiated ground motion and stresses from three-dimensional supershear ruptures". *J. Geophys. Res.* 113.B08319. DOI: 10.1029/2007JB005182.
- Bhat, H. S., Dmowska, R., King, G. C. P., Klinger, Y., and Rice, J. R. (2007a). "Off-fault damage patterns due to supershear ruptures with application to the 2001 M_w 8.1 Kokoxili (Kunlun) Tibet earthquake". *J. Geophys. Res.* B06301. DOI: 10.1029/2006JB004425.
- Bhat, H. S., Olives, M., Dmowska, R., and Rice, J. R. (2007b). "Role of fault branches in earthquake rupture dynamics". *J. Geophys. Res.* B11309. DOI: 10.1029/2007JB005027.
- Bhat, H. S. (2007). "Role of Geometric Complexities and Off-Fault Damage in Dynamic Rupture Propagation". PhD thesis. Harvard University.
- Fliss, S., Bhat, H. S., Dmowska, R., and Rice, J. R. (2005). "Fault branching and rupture directivity". *J. Geophys. Res.* B06312. DOI: 10.1029/2004JB003368.
- Bhat, H. S., Dmowska, R., Rice, J. R., and Kame, N. (2004). "Dynamic slip transfer from the Denali to Totschunda faults, Alaska: Testing theory for fault branching". *Bull. Seism. Soc. Am.* 94, S202–S213. DOI: 10.1785/0120040601.