

Harsha S. Bhat

Chargé de Recherche de Classe Normale, CNRS

École Normale Supérieure, Paris

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► PERSONAL INFORMATION

Email: bhat@geologie.ens.fr Nationality: Indian Website: <https://harshasbhat.github.io>

► EDUCATION

École Normale Supérieure, France	H. D. R. [†]	Supershear Earthquakes	2021/01
Harvard University, USA	Ph. D.*	Mechanical Sciences	2007/06
Harvard University, USA	M. S.	Engineering Sciences	2002/06
NITK, India	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	2016/05 ▶ Present	CNRS Research Scientist
Ecole Polytechnique, France	2022/09 ▶ Present	Teaching Professor (PCC)
NISER, India	2021/11 ▶ 2023/11	Visiting Professor

► PAST POSITIONS

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

► 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

► **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. Former students in gray.

Navid Kheirdast	<i>2022 onwards</i>	<i>Postdoc</i>	
Michelle Almakari	<i>2021 onwards</i>	<i>Postdoc</i>	
Carlos Villafuerte	<i>2021 onwards</i>	<i>Postdoc</i>	
Ekeabino Momoh	<i>2019 onwards</i>	<i>Postdoc</i>	
Lucile Bruhat	<i>2018-2021</i>	<i>Postdoc</i>	Natural Catastrophe Risk Analyst at AXA
Lisa Gordeliy	<i>2019</i>	<i>Postdoc</i>	Post Doctoral fellow at Ecole Polytechnique
Marion Y. Thomas	<i>2014-2016 & 2018</i>	<i>Postdoc</i>	CNRS Scientist at Sorbonne Université
Jinhui Cheng	<i>2021-2024</i>	<i>PhD</i>	
Augustin Thomas	<i>2020-2023</i>	<i>PhD</i>	
Joseph Flores Cuba	<i>2020-2023</i>	<i>PhD</i>	
Claudia Hulbert	<i>2018-2021</i>	<i>PhD</i>	Postdoc at ENS
Samson Marty	<i>2017-2020</i>	<i>PhD</i>	Postdoc at Penn. State Univ.
Marshall A. Martinez	<i>2014-2019</i>	<i>PhD</i>	Engineer at Joby Aviation
Kurama Okubo	<i>2015-2018</i>	<i>PhD</i>	Research Scientist at NIED, Japan
Pierre Romanet	<i>2014-2017</i>	<i>PhD</i>	Research Scientist at NIED, Japan
Vahe Gabuchian	<i>2010-2015</i>	<i>PhD</i>	Research Scientist at Caltech
François X. Passelègue	<i>2011-2014</i>	<i>PhD</i>	CNRS Scientist at GeoAzur, Nice
Jonathan Mihaly	<i>2008-2013</i>	<i>PhD</i>	Jet Propulsion Laboratory
Michael Mello	<i>2007-2012</i>	<i>PhD</i>	Teaching Professor at Caltech
Roxane Ferry	<i>2021</i>	<i>Master</i>	
Jinhui Cheng	<i>2020</i>	<i>Master</i>	
Phillipe Danre	<i>2019</i>	<i>Master</i>	
Nicolas Mercury	<i>2018</i>	<i>Master</i>	
Luc Illien	<i>2018</i>	<i>Master</i>	
Eleni Kolokytha	<i>2015</i>	<i>Master</i>	
Victor Barolle	<i>2015</i>	<i>Master</i>	
Kurama Okubo	<i>2014</i>	<i>Master</i>	
Thibaut Perol	<i>2013</i>	<i>Master</i>	
Lucile Bruhat	<i>2012</i>	<i>Master</i>	
Marion Olives	<i>2004</i>	<i>Master</i>	
Sonia Fliss	<i>2003</i>	<i>Master</i>	
Roxane Ferry	<i>2019</i>	<i>Bachelor</i>	
Hugo Lestrelin	<i>2019</i>	<i>Bachelor</i>	
Phillipe Danre	<i>2017</i>	<i>Bachelor</i>	

► TEACHING ACTIVITIES†

- | | |
|--|---|
| 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 |

† Classes taught with various colleagues at Harvard, Caltech, IPGP and ENS

► ORGANISATION OF SCIENTIFIC MEETINGS

- June 2019: Coupled Processes In Fracture Propagation In Geo-Materials: From Hydraulic Fractures To Earthquakes: CISM Advanced School, Udine, Italy
- April 2015: Seismological Society of America, Multiscale Modeling and Characterization of Fragmentation and Damage Patterns in Fault Zones
- December 2014: American Geophysical Union, Fault Zone Properties And Processes During Dynamic Ruptures

► INSTITUTIONAL RESPONSIBILITIES

- 2018 Onwards: Team Leader of Faults & Earthquakes Group, ENS (11 Researchers, 8 postdocs and 8 PhD students)
- 2018-2019: Co-organizer of the Internal Seminar, ENS

► LANGUAGES

English – Native | French – Conversant | Hindi – Fluent | Kannada – Native

► 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, M. Y., T. M. Mitchell, and H. S. Bhat, 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 H. S. Bhat, eds. (2012). "The mechanics of faulting: From laboratory to earthquakes". Research Signpost.

► BOOK CHAPTERS

Thomas, M. Y. and H. S. Bhat (2022). "Loi de friction et modélisation numérique du cycle sismique". in *Le Cycle Sismique*. Ed. by F. Rolandone. ISTE Editions.

► MANUSCRIPTS

Publications in peer reviewed international journals including Nature, Nature Communications and Science; edited volumes, theses and book chapters . h-index of 24 with an average of 149 citations per year since 2012.

Google Scholar ID: ZHskR34AAAAJ ORCID: 0000-0003-0361-1854

- Thomas, M. Y. and H. S. Bhat (2021). “Combined effects of fault roughness and off-fault damage on earthquake dynamics”. *in prep*.
- Romanet, P., H. S. Bhat, S. Chaillat, and R. Madariaga (2021). “Fast algorithms to model quasi-dynamic earthquake cycles in complex fault networks”. *to be subm. J. Geophys. Res.*
- Marty, S., H. S. Bhat, J. Aubry, E. Fukuyama, R. Madariaga, and A. Schubnel (2021). “Dominantly Aseismic Nucleation of Laboratory Earthquakes: A Quantitative Investigation”. *to be subm. J. Geophys. Res.*
- Amlani, F., H. S. Bhat, W. J. F. Simons, A. Schubnel, C. Vigny, A. J. Rosakis, J. Efendi, A. Elbanna, P. Dubernet, and H. Z. Abidin (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, J., L. Bruhat, M. Y. Thomas, S. Antoine, K. Okubo, Y. Klinger, R. Jolivet, and H. S. Bhat (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, A., M. Abdelmeguid, X. Ma, F. Amlani, H. S. Bhat, C. Synolakis, and A. J. Rosakis (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, L., N. Cubas, H. S. Bhat, and P. Steer (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., M. Simons, Z. Duputel, J.-A. Olive, H. S. Bhat, and Q. Bletery (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., E. Rougier, Z. Lei, and H. S. Bhat (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., H. S. Bhat, E. Rougier, S. Marty, A. Schubnel, Z. Lei, E. E. Knight, and Y. Klinger (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., F. X. Passelègue, J. Aubry, A. Schubnel, H. S. Bhat, and R. Madariaga (2019). “Origin of high-frequency radiation during laboratory earthquakes”. *Geophys. Res. Lett.* 46. DOI: 10.1029/2018GL080519.
- Aubry, J., F. X. Passelègue, D. Deldicque, F. Girault, S. Marty, A. Lahfid, H. S. Bhat, J. Escartin, and A. Schubnel (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., C. D. Villafuerte, and H. S. Bhat (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, M. Y. and H. S. Bhat (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, P., H. S. Bhat, R. Jolivet, and R. Madariaga (2018). “Fast and slow earthquakes emerge due to fault geometrical complexity”. *Geophys. Res. Lett.* DOI: 10.1029/2018GL077579.
- Gabuchian, V., A. J. Rosakis, H. S. Bhat, R. Madariaga, and H. Kanamori (2017). “Experimental evidence that thrust earthquake ruptures might open faults”. *Nature* 545.336–339. DOI: 10.1038/nature22045.
- Thomas, M. Y., H. S. Bhat, and Y. Klinger (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, F. X., S. Latour, A. Schubnel, S. Nielsen, H. S. Bhat, and R. Madariaga (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 H. S. Bhat (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.
- Passelègue, F. X., A. Schubnel, S. Nielsen, H. S. Bhat, D. Deldicque, and R. Madariaga (2016). “Dynamic rupture processes inferred from laboratory microearthquakes”. *J. Geophys. Res.* 121. DOI: 10.1002/2015JB012694.
- Mello, M., H. S. Bhat, and A. J. Rosakis (2016). “Spatiotemporal properties of sub-Rayleigh and supershear rupture velocity fields : Theory and Experiments”. *J. Mech. Phys. Solids* 93, pp. 153–181. DOI: 10.1016/j.jmps.2016.02.031.
- Vallage, A, Y Klinger, R Grandin, H. S. Bhat, and M Pierrot-Deseilligny (2015). “Inelastic surface deformation during the 2013 Mw 7.7 Balochistan, Pakistan, earthquake”. *Geology* 43.12, pp. 1079–1082. DOI: 10.1130/G37290.1.
- Frank, W. B., N. M. Shapiro, A. L. Husker, V Kostoglodov, H. S. Bhat, and M Campillo (2015). “Along-fault pore-pressure evolution during a slow-slip event in Guerrero, Mexico”. *Earth Planet. Sc. Lett.* 413, pp. 135–143. DOI: 10.1016/j.epsl.2014.12.051.
- Siriki, H., H. S. Bhat, X. Lu, and S. Krishnan (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., H. S. Bhat, A. J. Rosakis, and H. Kanamori (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, F. X., A. Schubnel, S. Nielsen, H. S. Bhat, and R. Madariaga (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., A. J. Rosakis, and C. G. Sammis (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., C. G. Sammis, and A. J. Rosakis (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.
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- Biegel, R. L., H. S. Bhat, C. G. Sammis, and A. J. Rosakis (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., H. S. Bhat, A. J. Rosakis, and H. Kanamori (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.
- Templeton, E. L., H. S. Bhat, R. Dmowska, and J. R. Rice (2010). “Dynamic rupture through a branched fault configuration at Yucca Mountain and resulting ground motions”. *Bull. Seism. Soc. Am.* 100.4, pp. 1485–1497. DOI: 10.1785/012009012110.1785/0120090121.
- 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., A. J. Rosakis, and H. S. Bhat (2009). “Effects of Off-fault Damage on Earthquake Rupture Propagation: Experimental Studies”. *Pure Appl. Geophys.* 166. DOI: 10.1007/s00024-009-0512-3.
- Templeton, E. L., A. Baudet, H. S. Bhat, R. Dmowska, J. R. Rice, A. J. Rosakis, and C. E. Rousseau (2009). “Finite Element Simulations of Dynamic Shear Rupture Experiments and Dynamic Path Selection Along Kinked and Branched Faults”. *J. Geophys. Res.* B08304. DOI: 10.1029/2008JB006174.
- Dunham, E. M. and H. S. Bhat (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., R. Dmowska, G. C. P. King, Y. Klinger, and J. R. Rice (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., M. Olives, R. Dmowska, and J. R. Rice (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., H. S. Bhat, R. Dmowska, and J. R. Rice (2005). "Fault branching and rupture directivity". *J. Geophys. Res.* B06312. DOI: 10.1029/2004JB003368.
- Bhat, H. S., R. Dmowska, J. R. Rice, and N. Kame (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.