Vijay Varma ***Curriculum Vitae***

CONTACT INFORMATION
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RESEARCH INTERESTS
Numerical Relativity, Gravitational Wave Physics, and Relativistic Astrophysics.

EDUCATION

Ph.D. Physics May 2019

California Institute of Technology, Pasadena, USA.
Thesis: *Black hole simulations: from supercomputers to your laptop.*

M.Sc. Physics and B.E. Mechanical Engineering June 2014

Birla Institute of Technology and Science, Pilani, India.

EMPLOYMENT

Klarman Postdoctoral Fellow, Cornell University.
Mentor: Prof. Saul Teukolsky. July 2020 to June 2021

Postdoctoral scholar, California Institute of Technology.
Mentor: Prof. Saul Teukolsky. June 2019 to June 2020

Graduate student, California Institute of Technology.
Advisors: Prof. Mark Scheel and Prof. Yanbei Chen. Oct 2014 to May 2019

Visiting student, ICTS, Bangalore.
Advisor: Prof. Parameswaran Ajith. Aug 2013 to July 2014

Summer student, RRI, Bangalore.
Advisor: Prof. Bala Iyer. May 2012 to July 2012

AWARDS/HONORS

Marie Curie Fellowship, Albert Einstein Institute, Potsdam. 2021-2023

Klarman Fellowship, Cornell University, Ithaca. 2020-2021

Honorable mention in the GWIC-Braccini PhD Thesis Prize competition. 2020

Prabhat Award for Best Outgoing Student in Physics, BITS, Pilani. 2013

PUBLICATION SUMMARY

- A total of **18** peer-reviewed, short-author publications.
- **10 as first-author**, out of which **2 covered by press releases.**
- 3 papers currently under review.
- Full publication profile, including LIGO publications, available on INSPIRE.

Peer-reviewed publications

18. L. Reali, M. Mould, D. Gerosa, and **Vijay Varma**.
Mapping the asymptotic inspiral of precessing binary black holes to their merger remnants.
Classical and Quantum Gravity, 37, 225005 (2020), arxiv:2005.01747.

17. K. Barkett, Y. Chen, M. Scheel, and **Vijay Varma**.
Gravitational waveforms of binary neutron star inspirals using PN Tidal Splicing.
Physical Review D, 102, 024031 (2020), arxiv:1911.10440.

16. F. Shaik, J. Lange, S. Field, R. O'Shaughnessy, **Vijay Varma**, L. Kidder, H. Pfeiffer, and D. Wysocki.
Impact of subdominant modes on the interpretation of gravitational-wave signals from heavy binary black hole systems.
Physical Review D, 101, 124054 (2020), arxiv:1911.02693.

15. **Vijay Varma**, M. Isi, and S. Biscoveanu.
Extracting the gravitational recoil from black hole merger signals.
Physical Review Letters, 124, 101104 (2020), arxiv:2002.00296.
In press: Cornell, Inside Science, phys.org.

14. N. Rifat, S. Field, G. Khanna, and **Vijay Varma**.
A Surrogate Model for Gravitational Wave Signals from Comparable- to Large-Mass-Ratio Black Hole Binaries.
Physical Review D, 101, 081502 (R) (2020), arxiv:1910.10473.

13. T. Islam, A. Mehta, A. Ghosh, **Vijay Varma**, P. Ajith, and B. Sathyaprakash.
Testing the"no-hair" nature of binary black holes using the consistency of multipolar gravitational radiation.
Physical Review D, 101, 024032 (2020), arxiv:1910.14259.

12. **Vijay Varma**, S. Field, M. Scheel, J. Blackman, D. Gerosa, L. Stein, L. Kidder, and H. Pfeiffer.
Surrogate models for precessing binary black hole simulations with unequal masses.
Physical Review Research, 1, 033015 (2019), arxiv:1905.09300.

11. M. Boyle, et al. (40 authors incl. **Vijay Varma**).
The SXS Collaboration catalog of binary black hole simulations.
Classical and Quantum Gravity, 36, 195006 (2019), arxiv:1904.04831.

10. A. Mehta, P. Tiwari, N. J. McDaniel, C. Mishra, **Vijay Varma**, and P. Ajith.
Including mode mixing in a higher-multipole model for gravitational waveforms from nonspinning black-hole binaries.
Physical Review D, 100, 024032 (2019), arxiv:1902.02731.

9. **Vijay Varma**, S. Field, M. Scheel, J. Blackman, L. Kidder, and H. Pfeiffer.
Surrogate model of hybridized numerical relativity binary black hole waveforms.
Physical Review D, 99, 064045 (2019), arxiv:1812.07865.

8. **Vijay Varma**, L. Stein, and D. Gerosa.
The binary black hole explorer: on-the-fly visualizations of precessing binary black holes.
Classical and Quantum Gravity, 36, 095007 (2019), arxiv:1811.06552.

7. **Vijay Varma**, D. Gerosa, L. Stein, F. Hebert, and H. Zhang.
High-accuracy mass, spin, and recoil predictions of generic black-hole merger remnants.
Physical Review Letters, 122, 011101 (2019), arxiv:1809.09125.
In press: Caltech, OleMiss, phys.org.

6. **Vijay Varma**, M. Scheel, and H. Pfeiffer.
Comparison of binary black hole initial data sets.
Physical Review D, 98, 104011 (2018), arxiv:1808.08228.

5. **Vijay Varma** and M. Scheel.
Constructing a boosted, spinning black hole in the damped harmonic gauge.
Physical Review D, 98, 084032 (2018), arxiv:1808.07490.

4. A. Mehta, C. Mishra, **Vijay Varma**, and P. Ajith.
Accurate inspiral-merger-ringdown gravitational waveforms for non-spinning black-hole binaries including the effect of subdominant modes.
Physical Review D, 96, 124010 (2017), arxiv:1708.03501.

3. **Vijay Varma** and P. Ajith.
Effects of nonquadrupole modes in the detection and parameter estimation of black hole binaries with nonprecessing spins.
Physical Review D, 96, 124024 (2017), arxiv:1612.05608.

2. **Vijay Varma**, P. Ajith, S. Husa, J. Bustillo, M. Hannam, and M. Pürrer.
Gravitational-wave observations of binary black holes: Effect of nonquadrupole modes.
Physical Review D, 90, 124004 (2014), arxiv:1409.2349.

1. **Vijay Varma**, R. Fujita, A. Choudhary, and B. Iyer.
Comparison of post-Newtonian templates for extreme mass ratio inspirals.
Physical Review D, 88, 024038 (2013), arxiv:1304.5675.

Papers under review

3. A. Taylor and **Vijay Varma**.
Gravitational wave peak luminosity model for precessing binary black holes.
Submitted to *Physical Review D*, arxiv:2010.00120.

2. S. Biscoveanu, M. Isi, S. Vitale, and **Vijay Varma**.
A new spin on LIGO-Virgo binary black holes.
Submitted to *Physical Review Letters*, arxiv:2007.09156.

1. Y. Huang, C. Haster, S. Vitale, **Vijay Varma**, F. Foucart, and S. Biscoveanu.
Statistical and systematic uncertainties in extracting the source properties of neutron star - black hole binaries with gravitational waves.
Submitted to *Physical Review D*, arxiv:2005.11850.

Unrefereed papers

1. B. Sathyaprakash, et al. (28 authors incl. **Vijay Varma**).
Extreme gravity and fundamental physics. arxiv:1903.09221.

Seminars and invited talks

- Lunch seminar, Cornell, Ithaca, Sep 2020.
- Strong gravity seminar, Perimeter Institute, Waterloo, Nov 2019.
- Lunch seminar, Cornell, Ithaca, Oct 2019.
- GR seminar, University of Jena, Jena, Oct 2019.
- Astrophysical and Cosmological Relativity seminar, AEI, Potsdam, Oct 2019.
- Astrophysics seminar, University of Birmingham, Birmingham, Oct 2019.
- CaJAGWR seminar, Caltech, Pasadena, Aug 2019.
- GW-CMB seminar, IUCAA, Pune, May 2019.
- Physics seminar, IISER, Pune, May 2019.
- ICTS seminar, Bangalore, May 2019.
- Astrophysics seminar, IISc, Bangalore, May 2019.
- APS Press Conference, APS April meeting, Denver, April 2019.
- LIGO seminar, Caltech, Pasadena, Oct 2018.

Mentorship

- MIT summer student Afura Taylor. *Data driven modeling of peak luminosity of black hole mergers.* Summer 2019.
  Paper: Submitted to *Physical Review D*, arxiv:2010.00120.
- Caltech summer student Jacqueline Lodman. *Developing a surrogate model of eccentric black hole binary systems.* Summer 2019.
- Peking University summer student Hao Zhang. *Gaussian process regression for numerical relativity surrogate models.* Summer 2017.
  Paper: *Physical Review Letters*, 122, 011101 (2019), arxiv:1809.09125.

Service

Journal referee: *Physical Review D*, *Physical Review Letters*, Scientific Reports.

External reviewer: NASA FINESST.

Seminar organization:

- Cornell Astrophysics Lunch 2020-2021.

Outreach

- Wrote popular science article on *Ripples from colliding black holes*, for Caltech letters, March 2019.
- Gave public talk on *Tumbling black holes*, for Astronomy on Tap, Pasadena, March 2019.
- Developed the binary black hole explorer, a teaching tool aimed at undergraduate and graduate students, to learn about precessing binary black hole mergers through visualizations, Nov 2018.
- Invited speaker for BITS Embryo Lecture on *A career in Science*, Feb 2015.

Contributions at Conferences

- Talk on *Extracting the gravitational recoil from black hole merger signals* at Virtual APS April meeting, April 2020.
- Talk on *Surrogate model of the waveform and remnant properties of precessing binary black holes* at GR22-Amaldi13, Valencia, July 2019.
- Talk on *Data-driven modeling of numerical relativity simulations* at AstroInformatics, Caltech, June 2019.
- Talk on *Numerical relativity surrogate waveform model for precessing binary black holes* at APS April meeting, Denver, April 2019.
- Talk on *A surrogate model of hybridized NR waveforms* at Workshop on Reduced Order Modeling, AEI, Potsdam, June 2018.
- Talk on *Aligned-spin surrogate model with higher order modes* at APS April meeting, Columbus, April 2018.
- Talk on *Gravitational waveforms beyond BBH by tidal splicing* at APS April meeting, Columbus, April 2018 (On behalf of K. Barkett).
- Talk on *Aligned-spin surrogate model with higher order modes* at Pacific Coast Gravity Meeting, Caltech, Pasadena, March 2018.
- Talk on *Gauge Conditions in Binary Black Hole Initial Data* at Pacific Coast Gravity Meeting, UC Santa Barbara, March 2017.
- Talk on *Gauge Conditions in Binary Black Hole Initial Data* at APS April Meeting, Washington, DC, Jan 2017.
- Talk on *Computing Binary Black Hole Initial Data in Damped Harmonic Gauge* at APS April Meeting, Salt Lake City, April 2016.
- Talk on *Computing Binary Black Hole Initial Data in Damped Harmonic Gauge* at Theoretical Astrophysics in Southern California (TASC) Meeting, CSU Fullerton, Nov 2015.
- Poster presentation on *Gravitational-wave observations of binary black holes: Effect of nonquadrupole modes* at Gravitational Wave Physics and Astronomy Workshop, IUCAA, Pune, Dec 2013.

Other Conferences and Meetings Attended

- LVC Meeting, Lake Geneva, March 2019.
- LVC Meeting, Maastricht, Sep 2018.
- Workshop on The Architecture of LISA Science Analysis: Imagining the Future, Caltech, Pasadena, January 2018.
- LVC Meeting, Pasadena, March 2015.
- Caltech Gravitational Wave Astrophysics School, Caltech, Pasadena, July 2015.
- Fifth International ASTROD Symposium on Laser Astrodynamics, Space Test of Relativity and Gravitational-Wave Astronomy, RRI, Bangalore, July 2012.
- ICTS Summer School on Numerical Relativity, ICTS, Bangalore, June 2013.
- BITS-IUCAA Workshop on Gravitational-Wave Data Analysis, Goa, Dec 2012.

Computing Skills

Languages: Expert in Python. Proficient in C/C++, Mathematica and Matlab.

Operating systems: Mac OS, Linux/*nix. Experience with working on high performance supercomputers.

Contributions: Most contributions can be found at github.com/vijayvarma392.

- Developer and maintainer of PyPI packages surfinBH, binaryBHexp and gwsurrogate.
- Member of the Simulating eXtreme Spacetimes (SXS) collaboration, contributor to the Spectral Einstein Code (SpEC).
- Member of the LIGO scientific collaboration, contributor to the LIGO Algorithm Library - LALSuite.