

# Sashwat Tanay

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[Google Scholar](#), [LinkedIn](#)

## EDUCATION

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<b>Ph.D. (Physics)</b> University of Mississippi	2016-2022
<b>Advisor:</b> Prof. Leo C. Stein	
<b>Dissertation:</b> Post-Newtonian Dynamics of Eccentric, Spinning Binary Black Holes and the Associated Gravitational Waveforms	
<b>B.Tech. (Mechanical Engineering)</b> Indian Institute of Technology Ropar	2009-2013

## EMPLOYMENT

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<b>Postdoctoral Fellow</b> LUTH, Paris Observatory - PSL University	2023-2025
<b>Adjunct Instructor</b> University of Mississippi	2022-2023
<b>Teaching and Research Assistant</b> University of Mississippi	2016-2022
<b>Junior Research Fellow</b> Tata Institute of Fundamental Research, Mumbai	2013-2015

## AWARDS & FELLOWSHIPS

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Awarded the PSL Postdoctoral Fellowship to conduct independent research at the Paris Observatory.	
Postdoctoral Fellowship, Paris Observatory - PSL University	2023-2025
FGSA Travel Award for Excellence in Graduate Research, APS (\$500)	2022
Graduate School Honors Fellowship, Univ. of Mississippi (\$12,000 in total)	2016-2020
Junior Research Fellowship, Tata Institute of Fundamental Research, Mumbai	2013-2015

## RESEARCH INTERESTS

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A total of 10 research papers (published and in prep.), plus 1 set of [lecture notes](#), supplemented by computer codes on [GitHub](#).

- Gravitational waves (GWs) • Post-Newtonian (PN) dynamics of binary black holes (BBHs) • Quasi-normal mode (QNM) ringdown of black holes (BHs) • Hamiltonian dynamical systems • Extreme mass ratio inspirals (EMRIs)
- Found closed-form solutions to the trajectories of spinning BBHs at 1.5PN and 2PN order • Discovered two new constants of motion for these systems at 2PN order • Constructed orbital solutions of non-spinning BBHs at 4PN and the associated GWs • Performed data-analysis oriented studies on non-spinning BBHs in the context of detectability of GWs emanating from them • Improved the computation of QNM frequencies of spinning BHs • Computed the action-angle variables (AAVs) and the associated frequencies for spinning PN BBHs and EMRI systems within Hamiltonian mechanics. • Discovered that the “orbit-averaged” 2PN spinning BBH system is an integrable Hamiltonian system; constructed its Hamiltonian and AAVs. • Located its separatrices and resonances using these AAVs.

## TEACHING EXPERIENCE

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- Phys 211** Instructor of record Summer 2023  
(Adjunct Instructor, Univ. of Mississippi; [course website here](#))
- Developed and taught a calculus-based undergraduate physics course
  - Created course material, delivered lectures and assessed student performance
- Phys 221, 222, 223, 224** Undergrad physics lab courses 2016-2022  
(Teaching Assistant, Univ. of Mississippi)
- Assisted in undergraduate physics lab courses
  - Conducted lab sessions, and graded assignments

## MENTORING

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Supervision of 3 mentees have resulted in 3 research papers (one published and two in prep.), and that of a 4<sup>th</sup> mentee into an undergrad thesis.

- Tom Colin** (postgrad, Ecole Normale Supérieure, Paris) led to Publication (1) Oct 2023-present
- Manuel Alva** (undergrad, Universidad Nacional de Trujillo, Peru) led to Publication (1) Nov 2023-present
- Rickmoy Samanta** (postdoc, ISI Kolkata) led to Publication (4) Sep 2021-Sep 2022
- Pranav Kasetty** (undergrad thesis co-advisor, IISc Bengaluru) Oct 2021-Apr 2022

## COMPUTER SKILLS

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- Mathematica (xAct), C/C++, Python, Fortran, Matlab, Jekyll (web development), Bash
- Machine learning: scikit-learn ([GitHub portfolio](#))

## PROFESSIONAL SERVICE

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- Referee** Physical Review & Physical Review Letters Feb 2023-present

## INVITED TALKS & LECTURES

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- York University, Toronto (Department Colloquium) Dec 2024
- Institut d'astrophysique de Paris (GReCO seminar) Jan 2024
- IISER Pune (Physics Seminar) Jan 2024
- Missouri University of Science and Technology (Department Colloquium) Aug 2023
- Northwestern University Jul 2023
- Univ. of Illinois Urbana-Champaign (lecture workshop; lecture notes [here](#)) Jun 2022
- Montana State Univ. (Relativity, Astrophysics and Space Science Seminar) Apr 2022
- Max Planck Inst. for Gravitational Physics Potsdam (ACR Seminar, *remote*) Jun 2021
- Simon Fraser Univ. (Cosmology Seminar, *remote*) Sep 2020

## OUTREACH & SERVICE

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- Public Talk on Astronomy - Univ. of MS (2023)
- Judge at The Speaker's Edge Competition 2022 - Univ. of MS
- Organized STEM Summer Camp - Univ. of MS (2018, 19)
- Organized Spooky Physics Night - Univ. of MS (2016, 17, 18)
- Public talk in French (Journée du LUTH), Paris Observatory (2024)
- YouTube videos on [research](#) and [popular science](#)

**Fluent:** English, Hindi    **Elementary:** French (A1-A2)

PUBLICATIONS AND RESEARCH ARTICLES

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1. \*T. Colin, **S. Tanay**, and L. Bernard. Solutions of spinning, eccentric binary black holes at 2<sup>nd</sup> post-Newtonian order, *in prep.* 2024
2. †T. Colin, **S. Tanay**, M. A. Morales, and L. Bernard. Orbit-averaged dynamics of spinning binary black holes in a Hamiltonian framework at 2<sup>nd</sup> post-Newtonian order, *in prep.* 2024
3. V. Witzany, V. Skoupý, L. C. Stein, and **S. Tanay**. Actions of spinning compact binaries: Spinning particle in Kerr matched to dynamics at 1.5 post-Newtonian order, 2024, [arXiv:2411.09742](#) (submitted)
4. **S. Tanay**. Towards a more robust algorithm for computing the Kerr quasinormal mode frequencies, 2022, [arXiv:2210.03657](#) (to be submitted)
5. R. Samanta, **S. Tanay**, and L. C. Stein. Closed-form solutions of spinning, eccentric binary black holes at 1.5 post-Newtonian order. *Phys. Rev. D*, 108(14):124039, 2023, [arXiv:2210.01605](#)
6. **S. Tanay**. Integrability and action-angle-based solution of the post-Newtonian BBH system (lecture notes), 2022, [arXiv:2206.05799](#)
7. **S. Tanay**, G. Cho, and L. C. Stein. Action-angle variables of a binary black hole with arbitrary eccentricity, spins, and masses at 1.5 post-Newtonian order. *Phys. Rev. D*, 107(26):103040, 2021, [arXiv:2110.15351](#)
8. G. Cho, **S. Tanay**, A. Gopakumar, and H. M. Lee. Generalized quasi-Keplerian solution for eccentric, nonspinning compact binaries at 4PN order and the associated inspiral-merger-ringdown waveform. *Phys. Rev. D*, 105(6):064010, 2022, [arXiv: 2110.09608](#)
9. **S. Tanay**, L. C. Stein, and J. T. Gálvez Gherzi. Integrability of eccentric, spinning black hole binaries up to second post-Newtonian order. *Phys. Rev. D*, 103(6):064066, 2021, [arXiv: 2012.06586](#)
10. **S. Tanay**, A. Klein, E. Berti, and A. Nishizawa. Convergence of Fourier-domain templates for inspiraling eccentric compact binaries. *Phys. Rev. D*, 100(6):064006, 2019, [arXiv:1905.08811](#)
11. **S. Tanay**, M. Haney, and A. Gopakumar. Frequency and time domain inspiral templates for comparable mass compact binaries in eccentric orbits. *Phys. Rev. D*, 93(6):064031, 2016, [arXiv:1602.03081](#)

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\*We construct an analytical solution of the positions, and spin angular momenta as functions of time of the two black hole components in the binary black hole system at 2PN order.

†For the 2PN spinning orbit-averaged binary black hole system, we • construct its action-angle variables (AAV) and its AAV-based closed-form solution • locate its separatrices and resonances.