Sashwat Tanay

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EDUCATION

Ph.D. (Physics) University of Mississippi 2016-2022
Advisor: Prof. Leo C. Stein
Dissertation: Post-Newtonian Dynamics of Eccentric, Spinning Binary Black Holes and the Associated Gravitational Waveforms

B.Tech. (Mechanical Engineering) Indian Institute of Technology Ropar 2009-2013

EMPLOYMENT

Postdoctoral Fellow LUTH, Paris Observatory - PSL University 2023-2025

Adjunct Instructor University of Mississippi 2022-2023

Teaching and Research Assistant University of Mississippi 2016-2022

Junior Research Fellow Tata Institute of Fundamental Research, Mumbai 2013-2015

AWARDS & FELLOWSHIPS

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

A total of 9 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

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

Supervision of 3 mentees have resulted in 2 research papers (one published and one in prep.), and that of a 4^{th} 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

• Mathematica (xAct), C/C++, Python, Fortran, Matlab, Jekyll (web development), Bash • Machine Learning, data science (scikit-learn, Kaggle) • GitHub

PROFESSIONAL SERVICE

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

INVITED TALKS & LECTURES

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

• 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

LANGUAGES

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

REFERENCES

- Dr. Leo C. Stein
  University of Mississippi
  lcstein@olemiss.edu
- Dr. Emanuele Berti
  Johns Hopkins University
  berti@jhu.edu
- Dr. Laura Bernard
  Paris Observatory
  laura.bernard@obspm.fr

PUBLICATIONS AND RESEARCH ARTICLES

1. T. Colin, **S. Tanay**, M. A. Morales, and L. Bernard. Revisiting 2PN Hamiltonian mechanics of binary black holes, *in prep.* 2024
2. V. Skoupý, L. C. Stein, **S. Tanay**, and V. Witzany. Actions of spinning compact binaries: Spinning particle in Kerr matched to dynamics at 1.5 post-Newtonian order, *in prep.* 2024
3. **S. Tanay**. Towards a more robust algorithm for computing the Kerr quasinormal mode frequencies, 2022, arXiv:2210.03657 (to be submitted)
4. 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
5. **S. Tanay**. Integrability and action-angle-based solution of the post-Newtonian BBH system (lecture notes), 2022, arXiv:2206.05799
6. **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
7. 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
8. **S. Tanay**, L. C. Stein, and J. T. Gálvez Ghersi. Integrability of eccentric, spinning black hole binaries up to second post-Newtonian order. *Phys. Rev. D*, 103(6):064066, 2021, arXiv: 2012.06586
9. **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
10. **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