Sashwat Tanay

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Google Scholar, LinkedIn

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

PSL 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 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

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 3 research papers (one published and two in prep.), and that of a 4th 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

TECHNICAL SKILLS

- Numerical computing, analytical calculations, approximate solutions of differential equations using perturbative methods
- Machine learning & data with scikit-learn ([GitHub portfolio](#))
- **Computer:** Mathematica (xAct), C/C++, Python (scikit-learn), Fortran, Matlab, Jekyll (web development), Bash

PROFESSIONAL SERVICE

Referee Physical Review & Physical Review Letters   Feb 2023-present

INVITED TALKS & LECTURES

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

● Public talk in French (Journée du LUTH), Paris Observatory (2024) ● 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) ● YouTube videos on research and popular science

LANGUAGES

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

PUBLICATIONS AND RESEARCH ARTICLES

1. [*]T. Colin, **S. Tanay**, and L. Bernard. Solutions of spinning, eccentric binary black holes at 2nd 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 2nd 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 Ghersi. 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.

[†]We ● discover that the 2PN spinning orbit-averaged binary black hole system is an integrable Hamiltonian system; also give the Hamiltonian ● construct its action-angle variable (AAV) and its AAV-based closed-form solution ● locate its separatrices and resonances.