David Tsang

Contact Information

Department of Physics
University of Bath
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Personal

Canadian Citizenship

Research Expertise

Theoretical Astrophysics; Compact Objects; Neutron Stars; Pulsars and Magnetars; Black Holes; Gravitational Wave Physics; Accretion Disks; High Energy Astrophysics; Exoplanets; Protoplanetary Disks; Mathematical Physics; Variational Principles for Nonconservative Systems; Numerical Methods, Astrophysical (Magneto)Hydrodynamics; Geometric Mechanics

Academic History

University of Bath, Bath, UK
Lecturer, Department of Physics — 2018-present

University of Southampton, Southampton, UK
Research Fellow, Mathematical Sciences (Gravity Group & STAG Research Centre) — 2017-2018

University of Maryland, College Park, MD, USA
CTC Prize Postdoctoral Fellow, Department of Astronomy — 2015-2017

McGill University, Montréal, QC, Canada
Postdoctoral Scholar/Senior Research Associate, Department of Physics — 2012-2015

California Institute of Technology, Pasadena, CA, USA
Sherman Fairchild Prize Postdoctoral Fellowship, Theoretical Astrophysics — 2009-2012

Cornell University, Ithaca, NY, USA
Ph.D. Physics, Theoretical Astrophysics, "Global Instabilities of Accretion Disks" — 2009
M.S. Physics, Theoretical Astrophysics — 2006
Advisor: Dong Lai

University of British Columbia, Vancouver, BC, Canada
B.A.Sc. Engineering Physics, Electrical Engineering Specialization with Honours Mathematics, Commerce Minor — 2002

Current Research Interests

My research focuses on astrophysical dynamics in a wide variety of systems and contexts. I study the relativistic astrophysics of neutron stars and black holes. I am interested in dynamical resonance of binaries, particularly for neutron stars, as a source of possible electromagnetic counterparts to gravitational wave signals, and as a probe of physics within the neutron star crust. I work closely with pulsar and magnetar observers, and nuclear astrophysicists, using timing properties of both individual objects and the larger population to infer information about the dynamical processes within these neutron stars and their magnetospheres. I study the dynamical stability of black hole accretion disks to explain QPOs in X-ray binary systems, as well as the observational signatures of such modes in black hole and neutron star spacetimes.

I also study the formation and and evolution of planetary systems, in particular looking for signatures of dynamical processes in the growing statistical sample of exoplanets now being detected and characterised. I have shown how several mechanisms involving disk-planet interactions could explain emerging features of the exoplanet population.

I helped develop a new variational principle for non-conservative discrete systems and classical field theories, in particular for non-Hamiltonian N-body dynamics, dissipative fluid dynamics and non-ideal magnetohydrodynamics. I exploited this formalism to develop new analytic and numerical methods for a wide variety of systems that experience nonconservative phenomena, including orbital dynamics. I am currently exploring applying this formalism to geometric hydrodynamics, including dissipation, in order to obtain coarse-grained actions.

Research Experience

University of Bath, Bath UK 2018-present
Lecturer, Theoretical Astrophysics, Department of Physics
PhD Students: Duncan Neill (Physics 2019-present), **Rosa Kowalewski** (Maths, 2019-present)
MPhys/MSci Students: Oli Harris (21/22), Martynas Jurkonis (21/22), Lewis Kinchin (20/21), Joe Taylor (20/21), Joseph Buckley (20/21), Sanjay Sharma (20/21), Eszeter Kovacs (19/20), Sam Brooks-Martin (19/20), Henry Elsom (19/20), Jim Milsom-Thomas (19/20)
BSc Project Students: Ben Redden (21/22), Matthew MacDonald (21/22), Christopher French (18/19), Michael Sturman (18/19), Harvey Coplestone (18/19), Ellis Rohleder-Lukas (18/19)
Research Interns: Xavier Pritchard (21/22), Charles Valdez (2019 IMI internship)

- Resonant Shattering Flares
- Multimessenger Probes of Neutron Star Physics
- Compact Object Dyamics & Gravitational-Wave Physics
- N-body & Continuum Numerical Methods
- Dynamics and Structure of Astrophysical Discs
- Geometric Fluid Dynamics and Non-Hamiltonian Action Principles
- Mathematical Physics

University of Southampton, Southampton, UK 2017-2018
Research Fellow, Gravity Group & STAG Research Centre, Mathematical Sciences
Supervised by Prof. Nils Andersson

- Electromagnetic precursors to gravitational-wave mergers;
- Neutron Star Physics;
- Compact object dynamics and gravitational wave physics;
- N-body and Continuum Numerical Methods;
- Relativistic Astrophysical Fluid Dynamics and Magnetohydrodynamics

University of Maryland, College Park, MD, USA 2015-2017
CTC Prize Postdoctoral Fellow in Theoretical Astrophysics

- Numerical integrators for nonconservative astrophysical dynamics; Symplectic Integrators; Numerical methods;
- Exoplanetary structure and dynamics, protoplanetary disks;
- Compact object dynamics and gravitational wave physics;
- High-energy astrophysics; Black hole and neutron star physics;
- Astrophysical Fluid Dynamics

McGill University, Montreal, QC, Canada 2012 - 2015
Postdoctoral Scholar/Senior Research Associate in Theoretical Astrophysics
Supervised by Andrew Cumming and Vicky Kaspi.

- Neutron star physics, pulsar and magnetar phenomenology, magnetospheric physics;
- Dynamical encounters of compact objects in dense stellar environments: dynamical resonance, gravitational waves;
- Planet-disk interactions and eccentricity evolution for giant planets;
- Accretion disk physics and relativistic ray-tracing, supervising an undergraduate student at Caltech (I. Butsky);
- Variational principle for nonconservative mechanics and classical field theories;
- Variational integrators for nonconservative systems, supervising an undergraduate student at McGill (A. Turner).

California Institute of Technology, Pasadena, CA, USA 2009 - 2012
Sherman-Fairchild Prize Postdoctoral Fellow in Theoretical Astrophysics

- Astrophysics of relativistic accretion disks, hydrodynamics, MHD and instabilities;
- Study of neutron stars, Gamma-Ray bursts, and dynamical resonance;
- Protoplanetary disks and planet formation and migration;
- Gravitational wave physics.

Cornell University, Ithaca, NY, USA 2003 - 2009
Doctoral research and short term postdoc
Supervised by Dong Lai

- Astrophysics of relativistic accretion disks;
- Diskoseismic instabilities, and Magnetohydrodynamic instabilities in disks;
- Relativistic ray-tracing;
- Gravitational wave detector physics.

University of British Columbia, Vancouver, BC, Canada 2001 - 2002
Undergraduate engineering thesis project
Supervised by Matthew Choptuik

- Development of RNPL (Rapid Numerical Prototyping Language) for numerical relativity and computational physics;
- Parallelization and user interface development.

University of Western Ontario, London, ON, Canada Summer 2001
NSERC undergraduate research
Supervised by J. Daniel Christensen

- Spin-Foam models of quantum gravity;
- Parallel and Markov-Chain Monte-Carlo algorithms for calculating 10j symbols.

Teaching and Outreach

University of Bath

- PH10005/53 Vibrations, Waves, & Optics (Unit Convener) 2018-present
- PH30116 Data Analysis & Research Methods for Obs. Astro. (Support) 2019-present
- PH30025 Mathematical Methods: Complex Analysis (Unit Convener) 2019-present
- PH30056 Computational Physics B (Unit Convener) 2021-present
- PH40112 General Relativity & Cosmology (Unit Convener) 2018-present

B.K. Tippett & **D. Tsang**, *How To Build a TARDIS*, Chapter 12, pp 129-148, in *More Doctor Who And Philosophy*, eds. C. Lewis & P. Smithka, Open Court Publishers, Chicago, IL (2015)

McGill University

PHYS 632: Seminar in Astrophysics I - Astrophysical Transients (Instructor) Spring 2015
Astro-McGill Public Outreach, 2012-2015
Astro-McGill Podcast, Co-Host 2012-2015
Titanium Physicist Science Podcast, Titanium Physicist 2011-present

- To date more than 2 million downloads
- Finalist for 2013 and 2014 Parsec Awards for "Best Fact Behind the Fiction Podcast"

Communicating Science: A Workshop for Scientists, UCLA, Participant, July 2011

Cornell University

TA Training Workshop Instructor/Organizer Summer 2006-2008
Physics Dept. Outreach: Demo Presentations 2004-2008
Cornell University courses taught (section instructor):

- Physics 360/363: Electronics Lab Spring 2003, 2004
- Physics 341: Statistical Mechanics Fall 2006
- Physics 217: Electricity and Magnetism Fall 2004
- Physics 214: Optics, Waves & Particles Summer 2003
- Physics 213: Heat, Electricity & Magnetism Fall 2002, 2005, Summer 2006
- Physics 112: Mechanics Fall 2003, Spring 2005, 2006, 2007
- Physics 101/102: General Physics Summer 2004, 2005

University of British Columbia

Undergraduate Teaching Assistant 1998-2002
UBC High School Physics Olympics Facilitator/Event Coordinator 1998-2002
ScienceWORKS Volunteer Elementary School Outreach Facilitator 2000-2002
Tutor: High-school/College Physics and Mathematics 1996-2009

PUBLICATIONS
(13 FIRST AUTHOR)
† DENOTES SUPERVISED STUDENT

26. R. Kowalewski†, **D.Tsang**, & K. Matthies, *Geometric Dissipative Hydrodynamics and the Euler-Poincaré Equations*, (in prep, ∼2022)
25. D. Neill†, **D.Tsang**, H.J. van Eerten, G. Ryan, & W.G. Newton, *Resonant Shattering Flares in Black Hole-Neutron Star and Binary Neutron Star Mergers*, (in prep, 2021)
24. D. Neill†, W.G. Newton, & **D. Tsang**, *Resonant Shattering Flares as Multimessenger Probes of Nuclear Symmetry Energy*, MNRAS, 504, 1,1129, (2021)
23. A. J. Watts, et al. (inc. **D. Tsang**), *Dense matter with eXTP*, Science China Physics, Mechanics & Astronomy, 62, 2, 29503, (2019)
22. S. Mandhai, N. Tanvir, G. Lamb, A. Levan, & **D. Tsang**, *The Rate of Short-Duration Gamma-Ray Bursts in the Local Universe*, Galaxies, 6, 4, 130, (2018)
21. J. D. Schnittman, T. Dal Canton, J. Camp, **D. Tsang** & B. J. Kelly, *Electromagnetic Chirps from Neutron Star-Black Hole Mergers*, ApJ, **853**, 123, (2018)
20. B. K. Tippett & **D. Tsang**, *Traversable Acausal Retrograde Domains In Spacetime*, Class. Quant. Grav., 34 095006 (2017)
19. **D. Tsang** & G. Pappas, *Self-Trapping of Diskoseismic Corrugation Modes in Neutron Star Spacetimes*, ApJL, 818, L11, (2016)
18. **D. Tsang**, C.R. Galley, L.C. Stein, & A. Turner†, *Slimplectic Integrators: Variational Integrators for General Nonconservative Systems*, ApJL, **809**, 1, L9, (2015)
17. C.R. Galley, **D. Tsang**, & L.C. Stein, *The Principle of Stationary Nonconservative Action for Classical Mechanics and Field Theories*, arXiv:1412.3018, (2014)
16. **D. Tsang**, N. J. Turner, & A. Cumming, *Shedding Light on the Eccentricity Valley: Gap Heating and Eccentricity Excitation of Giant Planets in Protoplanetary Disks*, ApJ **782**, 2, 113 (2014)
15. **D. Tsang**, *Linear Corotation Torques in Non-Barotropic Disks*, ApJ, **782**, 2, 112, (2014)
14. **D. Tsang**, *Shattering Flares During Close Encounters of Neutron Stars*, ApJ, **777**, 103 (2013)
13. **D. Tsang**, & I. Butsky†, *Iron Line Variability of Discoseismic Corrugation Modes*, MNRAS, **435**, 749-765 (2013)
12. **D. Tsang** & K.N. Gourgouliatos, *Timing Noise in Pulsars and Magnetars and the Magnetospheric Moment of Inertia*, ApJL, **773**, L17 (2013)
11. D. Lai, W. Fu, **D. Tsang**, J. Horak, & C. Yu, *High-Frequency QPOs and Overstable Oscillations of Black-Hole Accretion Disks*, IAU Symposium, **290**, 57, (2013)
10. R. F. Archibald, V. M. Kaspi, C.-Y. Ng, K. N. Gourgouliatos, **D. Tsang**, P. Scholz, A. P. Beardmore, N. Gehrels, & J.A. Kennea, *An Anti-Glitch in a Magnetar*, Nature, **497**, 7451, 591-593 (2013)
9. **D. Tsang**, J. S. Read, T. Hinderer, A. L. Piro, & R. Bondarescu, *Resonant Shattering of Neutron Star Crusts*, Phys. Rev. Lett., **108**, 011102 (2012)
8. **D. Tsang**, *Protoplanetary Disk Resonances and Type I Migration*, ApJ **741**, 109 (2011)
7. **D. Tsang** & D. Lai, *Corotational Instability of Inertial-Acoustic Modes in Black-Hole Accretion Discs: Non-Barotropic Flows*, MNRAS **400**, 470-479 (2009)
6. **D. Tsang** & D. Lai, *Interface Mode Instabilities in Accretion Discs*, MNRAS, **396**, 589-597 (2009)
5. **D. Tsang** & D. Lai, *Corotational Absorption of Diskoseismic C-modes in Black Hole Accretion Discs*, MNRAS, **393**, 992-998 (2009)
4. D. Lai & **D. Tsang**, *Corotational Instability of Inertial-Acoustic Modes in Black Hole Accretion Discs and Quasi-Periodic Oscillations*, MNRAS, **393**, 979-991 (2009)
3. **D. Tsang** & D. Lai, *Super-Reflection in Fluid Discs: Corotation Amplifier, Corotation Resonance, Rossby Waves, and Overstable Modes*, MNRAS, **387**, 446-462 (2008)
2. A.P. Lundgren, R. Bondarescu, **D. Tsang** & M. Bondarescu, *Finite Mirror Effects in Advanced Interferometric Gravitational Wave Detectors*, Phys Rev D, **77**, 042003 (2008)
1. J.C. Baez, J.D. Christensen, T.R. Halford, & **D. Tsang**, *Spin Foam Models of Riemannian Quantum Gravity*, Class. Quant. Grav. **19** 4627-4648 (2002)

Selected Awards

Center for Theory and Computation Prize Fellowship (UMD)	2015
Sherman Fairchild Postdoctoral Prize Fellowship in Theoretical Astrophysics (Caltech)	2009
American Association of Physics Teachers Outstanding Teaching Assistant Award	2007
NSERC Undergraduate Summer Research Award	2001
UBC Outstanding Student Initiative Scholarship	1997-2002

Colloquia, Seminars, Talks and Posters

94. Colloquium Speaker (Nobel Prize explanation), University of Bath, Bath, UK 2020
93. Physics Colloquium, University of Patras, Greece 2020
92. Astrophysics Colloquium, University of Leicester, UK 2020
91. Astrophysics Colloquium, University of East Anglia, UK 2019
90. University of East Anglia, Visiting Lecturer, UK 2019
89. Public Talk, Bath Royal Literary and Scientific Institution, Bath, UK 2019
88. Invited Speaker, Masterclasses in Relativistic Fluid Dynamics, Southampton, UK 2019
87. Contributed Talk, National Astronomy Meeting, Lancaster, UK 2019
86. Contributed Talk, SPINS-UK, London, UK 2019
85. Public Talk, Pint of Science, Bath, UK 2019
84. Invited Talk, INT Workshop on Astro-solids, Dense Matter, and GWs, Seattle, USA 2018
83. Astrophysics Seminar, Queen Mary University, London, UK 2018
82. Theory Group Seminar, Lund Observatory, Lund University, Sweden 2017
81. Planet Formation Group Seminar, Lund Observatory, Lund University, Sweden 2017
80. Astronomy Seminar, Lund Observatory, Lund University, Sweden 2017
79. Invited Speaker, Num. Integration Methods in Planetary Sci., U. of Toronto, Canada 2017
78. Invited Speaker, Physics of Extreme Gravity Stars, NORDITA, Stockholm, Sweden 2017
77. Astrophysics Seminar, University of Bath, UK 2017
76. Applied Mathematics Seminar, University of Southampton, UK 2016
75. Astronomy Seminar, University of Leicester, UK 2016
74. Astrophysics Seminar, University of Bristol, UK 2016
73. Astrophysics Seminar, University of Warwick, UK 2016
72. Talk, JSI Workshop on Multimessenger Astrophysics, Annapolis, MD 2016
71. Astrophysics Colloquium, NASA Goddard Space Flight Center, Greenbelt, MD 2016
70. Posters, National Astronomy Meeting, University of Nottingham, Nottingham, UK 2016
69. Astrophysics Seminar, University of Birmingham, Birmingham, UK 2016
68. Invited Talk, ICNT meeting on r-process nucleosynthesis, East Lansing, Michigan 2016
67. Mathematics Seminar, University of Leeds, Leeds, UK 2016
66. Poster, 22th AAS Meeting, Kissimmee, Florida 2016
65. Astrophysics Colloquium, Radboud University, Nijmegen, Netherlands 2015
64. Poster, Extreme Solar Systems III, Hawaii 2015
63. Astronomy Colloquium, University of Virginia/NRAO 2015
62. Physics Colloquium, University of Mississippi 2015
61. Astronomy Colloquium, University of British Columbia 2015
60. Talk, Emerging Researchers in Exoplanet Science Symposium, State College, PA 2015
59. Astrophysics Theory Seminar, University of Maryland 2015
58. Geophysics and Planetary Science Seminar, Caltech 2015
57. Poster, 225th AAS Meeting, Seattle, WA 2015
56. iPLEX Seminar, UC Los Angeles 2014
55. Séminaire d'astronomie et d'astrophysique, Université de Montréal 2014
54. Astrophysics Seminar, Institute for Advanced Study 2014
53. Special Astrophysics Seminar, University of Chicago 2014
52. Contributed Talk, AAS High Energy Astrophysics Division Meeting 2014
51. Astronomy Colloquium, Cornell University 2014
50. Relativity Lunch Seminar, Cornell University 2014
49. Astrophysics Colloquium, Massachusetts Institute of Technology 2014
48. Physics Colloquium, Cal. State Univ. Fullerton 2013
47. Poster, Second Kepler Science Conference, NASA Ames 2013
46. Postdoc Theory Lunch Talk, Caltech 2013
45. ITC Group Meeting Seminar, Harvard University 2013
44. CITA Seminar, University of Toronto 2013
43. Tea Talk, Carnegie Observatories 2013
42. 2 Posters, 221st AAS Meeting, Long Beach, CA 2013
41. Poster, Lorne-Trottier Workshop, McGill University 2012
40. Joint Astrophysics Colloquium, McGill University 2012
39. Talk, 220th AAS Meeting, Anchorage, Alaska 2012
38. Astronomy Tea Talk, Caltech 2012
37. CASS Seminar, UC San Diego 2012
36. Postdoc Theory Lunch Talk, Caltech 2012
35. Astrophysics Seminar, UC Santa Cruz 2012
34. Astrophysics Lunch Talk, UC Santa Barbara 2012
33. Astrophysics Seminar, University of Wisconsin-Milwaukee 2012
32. Poster, Rattle and Shine: GW and EM Studies of Compact Binary Mergers, KITP 2012
31. Herzberg Institute of Astrophysics (NRC-HIA) Colloquium, Victoria, BC 2012

30. Gravity Lunch, Physics and Astronomy Department, UBC, Vancouver, BC 2012
29. Institute of Astronomy Seminar, Cambridge University, UK 2011
28. Relativity Seminar, University of Southampton, UK 2011
27. Poster, IAU Symposium 285, New Horizons in Time-Domain Astronomy 2011
26. Tea Talk, Carnegie Observatories 2011
25. Talk, Theoretical Astrophysics in Southern California, KITP 2011
24. Simulating Extreme Spacetimes Video Seminar, Caltech/Cornell 2011
23. Talk, MICRA 2011 Workshop, Perimeter Institute 2011
22. Astrophysics Seminar, Penn State University 2011
21. Relativity Lunch Seminar, Cornell University 2011
20. Talk, 217th AAS Meeting, Seattle, Washington 2011
19. Postdoc Theory Lunch Talk, Caltech 2011
18. Talk, Theoretical Astrophysics in Southern California, Caltech 2010
17. Talk, KIAA Program on Astrophysics Disks, Peking University, Beijing, China 2010
16. Poster, Probing Strong Gravity Near Black Holes Conference, Prague, Czech Republic 2010
15. Seminar, AEI/MPI, Potsdam, Germany 2010
14. TAPIR Seminar, Caltech 2010
13. Poster, AAS HEAD Meeting, Big Island, Hawaii 2010
12. Postdoc Theory Lunch Talk, Caltech 2010
11. Talk, Theoretical Astrophysics in Southern California, USC 2009
10. Postdoc/Grad Student Seminar, Cornell University 2009
9. Talk, QPO Workshop, Stanford University 2009
8. Astrophysics Seminar, Los Alamos National Laboratory 2009
7. Relativity Seminar, Cornell University 2009
6. Talk, APS April Meeting, St. Louis, MO 2008
5. Relativity Seminar, Cornell University 2008
4. Plasma Astrophysics Seminar, Cornell University 2007
3. Group Meeting Seminar, TAPIR, Caltech 2007
2. Talk, Theoretical Astrophysics in Southern California, UCLA 2007
1. Relativity Seminar, Cornell University 2006

Professional Service

Postgraduate Student Staff Liaison Committee Member, University of Bath, 2019-present
National Astronomy Meeting, LOC/Organiser, University of Bath/RAS 2020-2021
Soton Gravity Seminar organizer, University of Southampton 2017-2018
eXTP Dense Matter Scientific Working Group member 2017-present
Center for Theory and Computation Seminar organizer, UMD 2016-2017
Scientific Organizing Committee member, EWASS 2016, S15 2016
Exploring pulsar formation, evolution and magnetic field
Panel Reviewer, National Science Foundation Grant Review Panel 2015
Co-Organizer, Weekly astro-ph discussion, McGill (2012-2015), UMD 2015-2017
Organizing Committee, Joint Astrophysics Colloquium, McGill 2013-2015
Moderator/Organizer, Daily astro-ph Discussion, Caltech, 2010-2012
Organizer, Theoretical Astrophysics Seminar, Caltech, 2009-2012
Referee, MNRAS, ApJ, PASJ, CQG 2009-present
Full Member, American Astronomical Society 2009-present

Activities and Leadership

Kodokan Judo, First Degree Black Belt (Shodan)
- Empire State Games Gold Medalist, 2006
- President, Cornell Judo Club 2006-2008
- Coach/Assistant Instructor (2 classes/week), Cornell Judo Club 2003-2009

The Cornell Lunatic Campus Humor Magazine, Cornell University
- Contributor, graduate student mentor, graphic design, layout editor 2006-2009

Engineering Physics Society, University of British Columbia
- President 2001-2002
- Vice-President 2000-2001

The nEUSpaper, Engineering Student Newspaper, University of British Columbia
- Editor-in-chief 2000-2002

References

Victoria Kaspi
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Mathematical Sciences,
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