Tristan C. Collins

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Citizenship: Canada, New Zealand

Education

2014 **Ph.D. in Mathematics**, *Columbia University*.
Advisor: Duong H. Phong

2009 **B.Sc. in Mathematics (Honours), Minor in Physics**, *University of British Columbia*.

Employment

2018 – **Assistant Professor**, *Massachusetts Institute of Technology*.

2014 – 2018 **Benjamin Peirce Fellow**, *Harvard University*, (on leave 01/2017- 06/2016).

01/2017- **Visiting Assistant Professor**, *Chalmers University*.
06/2017

Honors

2022-2025 Class of 1948 Career Development Assistant Professor, MIT

2021 André Aisenstadt Prize, Centre de Recherches Mathématiques

2020 Best Paper Award (Gold Medal), International Congress of Chinese Mathematicians

2018 Alfred P. Sloan Fellowship, Sloan Foundation

Research Grants and Funding

2019 – 2024 NSF CAREER Grant DMS-1944952, $400,000

2022 NSF Collaborative Research Grant DMS-2211917, $15,250

2018 Alfred P. Sloan Foundation, Sloan Fellowship, $65,000

2018 NSF Standard Grant DMS-1810924, $158,341.00

2015 NSF Standard Grant DMS-1506652, $128,224

Preprints

- *The Strominger system in the square of a Kähler class*
  (with S. Picard and S.-T. Yau)
  preprint, arXiv:2211.03784

- *Recent progress on SYZ mirror symmetry for some non-compact Calabi-Yau surfaces*
  (with Y.-S. Lin)
  preprint, arXiv:2208.14485

- *Uniqueness of some cylindrical tangent cones to special Lagrangians*
  (with Y. Li)
  preprint, arXiv:2208.02736

- *Complete Calabi-Yau metrics in the complement of two divisors*
  (with Y. Li)
  preprint, arXiv:2203.10656
- *On upper bounds in dimension gaps of CFT's*
  (with C. Vafa, D. Jafferis, K. Xu, and S.-T. Yau)
  preprint, arXiv:2201.03660
- *Spinor flows with flux, I: short-time existence and smoothing estimates*
  (with D.H. Phong)
  preprint, arXiv:2112.00814
- *Special Lagrangian cycles and Calabi-Yau transitions*
  (with S. Gukov, S. Picard and S.-T. Yau)
  preprint, arXiv:2111.10355.
- *The SYZ mirror symmetry conjecture for del Pezzo surfaces and rational elliptic surfaces*
  (with A. Jacob, and Y.-S. Lin)
  preprint, arXiv:2012.05416
- *Moment maps, nonlinear PDE, and stability in mirror symmetry*
  (with S.-T. Yau)
  preprint, arXiv:1811.04824
- *K stability and stability of chiral ring*
  (with D. Xie and S.-T. Yau)
  preprint, arXiv:1606.09260

Publications

- *The Torelli theorem for ALH* gravitational instantons*
  (with A. Jacob and Y.-S. Lin)
  Forum of Math., Sigma, to appear.
- *Moment maps, nonlinear PDE and stability in mirror symmetry, I: Geodesics*
  (with S.-T. Yau)
  Ann. PDE 7 (2021), no. 1, Paper No. 11, 73 pp.
- *Stability of the tangent bundle through conifold transitions*
  (with S. Picard and S.-T. Yau)
  Comm. Pure and Appl. Math., to appear.
- *Emergent Sasaki-Einstein geometry and AdS/CFT*
  (with R. Berman, and D. Persson)
  Nature Comm., 13, article 365.
- *On the degeneration of asymptotically conical Calabi-Yau metrics*
  (with F. Tong, and B. Guo)
  Math. Ann. 383 (2022), no. 3-4, 867–919.
- *Stability and the deformed Hermitian-Yang-Mills equation*
  (with Y. Shi), Surveys in Diff. Geom., to appear
- *The space of almost calibrated (1,1) forms on a compact Kähler manifold*
  (with J. Chu, and M.-C. Lee)
  Geom. Topol. 25 (2021), no. 5, 2573–2619.
- *The Dirichlet problem for the k-Hessian equation on a complex manifold*
  (with S. Picard)
  Amer. J. Math., to appear.

- *Special Lagrangian submanifolds of log Calabi-Yau manifolds*
  (with A. Jacob, and Y.-S. Lin)
  Duke Math. J. 170 (2021), no. 7,1291–1375.

- *Concave elliptic equations and generalized Khovanskii-Teissier inequalities*
  Pure Appl. Math. Q. 17 (2021), no. 3, 1061–1082.

- *The inverse Monge-Ampère flow and applications to KählerEinstein metrics*
  (with T. Hisamoto, and R. Takahashi)
  J. Differential Geom. 120 (2022), no. 1, 51–95.

- *The deformed Hermitian-Yang-Mills equation in geometry and physics*
  (with D. Xie, and S.-T. Yau)
  Geometry and Physics, Volume I: A Festschrift in honour of Nigel Hitch, Oxford University Press, December, 2018.

- *Log-canonical thresholds in real and complex dimension 2*
  Ann. Inst. Fourier (Grenoble), 68 (2018), no. 7, 2883–2900.

- *Restricted volumes on Kähler manifolds*
  (with V. Tosatti)
  Ann. Fac. Sci. Toulouse Math. (6) 31 (2022), no. 3, 907–947.

- *Sasaki-Einstein metrics and K-stability*
  (with G. Székelyhidi)
  Geom. Topol. 23 (2019), no. 3, 1339–1413.

- *$(1,1)$ forms with specified Lagrangian phase: A priori estimates and algebraic obstructions*
  (with A. Jacob and S.-T. Yau)
  Camb. J. Math. 8 (2020), no. 2, 407–452.

- *Dimension of the minimum set for the real and complex MongeAmpère equations in critical Sobolev spaces*
  (with. C Mooney)
  Anal. and PDE 10 (2017), no. 8, 2031–2041.

- *Concavity of the Lagrangian phase operator and applications*
  (with S. Picard and X. Wu)
  Calc. Var. Partial Differential Equations 56 (2017), no. 4, Art. 89.

- *Poisson metrics on flat vector bundles over non-compact curves*
  (with A. Jacob and S.-T. Yau)
  Comm. Anal. Geom. 27 (2019), no. 3, 529–597.

- *Convergence of the J-flow on toric manifolds*
  (with G.Székelyhidi)
  J. Differential Geom. 107 (2017), no. 1, 47–81.

- *K-Semistability for irregular Sasakian manifolds*
  (with G. Székelyhidi)
  J. Differential Geom. 109 (2018), no. 1, 81–109.

- *The twisted Kähler-Ricci flow*
  (with G. Székelyhidi)
  J. Reine Angew. Math., 716 (2016), 179–205.

- *Stability and convergence of the Sasaki-Ricci flow*
  J. Reine Angew. Math., 716 (2016), 1–27.

- *$C^{2,a}$ estimates for nonlinear elliptic equations of twisted type*
  Calc. Var. Partial Differential Equations 55 (2016), no. 6, Art. 6.

- *A singular Demailly-Păun theorem*
  (with V. Tosatti)
  C. R. Math. Acad. Paris 354 (2016), no. 1, 91–95.
- *Kähler currents and null loci*
  (with V. Tosatti)
  Invent. Math. 202 (2015), no. 3, 1167–1198.
- *On the convergence of the Sasaki-Ricci flow*
  (with A. Jacob)
  Analysis, complex geometry, and mathematical physics: in honor of Duong H. Phong, 11-21, Contemp. Math. 644 (2015).
- *An extension theorem for Kähler currents*
  (with V. Tosatti)
  Ann. Fac. Sci. Toulouse Math. (6) 23 (2014), no. 4, 893–905.
- *Uniform Sobolev inequality along the Sasaki-Ricci flow*
  J. Geom. Anal. 24 (2014), no. 3, 1323–1336.
- *Remarks on the Yang-Mills flow on a compact Kähler manifold*
  (with A. Jacob)
  Univ. Iagel. Acta Math., no. 51 (2013), 17–43.
- *The transverse entropy functional and the Sasaki-Ricci flow*
  Trans. Amer. Math. Soc. 365 (2013), no. 3, 1277–1303.
- *A multidimensional resolution of singularities with applications to analysis*
  (with A. Greenleaf, and M. Pramanik)
  Amer. J. Math. 135 (2013), no. 5, 1179–1252.

Research Talks

1/31/2012	City University of New York, Geometry and Analysis Seminar.
2/3/2012	University of Rochester, Analysis and Geometry Seminar.
10/9/2012	Northwestern University, Geometry and Physics Seminar.
5/8/2013	Columbia University, Analysis, Complex Geometry, and Mathematical Physics: A Conference in Honor of Duong H. Phong.
8/12/2013	Rutgers University, Summer School in Complex Geometry.
9/24/2013	Johns Hopkins University, Complex Geometry Seminar.
10/7/2013	University of Connecticut, PDE and Differential Geometry Seminar.
11/15/2013	Northwestern University, Complex Geometry Seminar.
3/25/2014	Duke University, Geometry and Topology Seminar.
4/5/2014	University of New Mexico, AMS Spring Sectional Meeting: Special Session on Analysis and Topology in Special Geometries.
4/8/2014	Banff International Research Station, Complex Monge-Ampère equations on compact Kähler manifolds.
9/30/2014	Temple University, PATCH Seminar.
10/10/2014	Harvard University, Gauge Theory, Topology and Symplectic Geometry Seminar.
10/21/2014	Harvard University, Differential Geometry Seminar.
11/21/2014	Northwestern University, Informal Geometric Analysis Seminar.
4/11/2015	Northwestern University, Special Day on Analytic Methods in Algebraic Geometry.

4/16/2015	Columbia University, Complex Geometry and PDE Seminar.
4/21/2015	University of California, Differential Geometry Seminar.
5/8/2015	Fields Institute, Geometric Analysis Colloquium.
6/2/2015	Jagiellonian University, Hessian Type Equations in Complex Geometry.
10/9/2015	Simons Center for Geometry and Physics, Workshop on Toric Kähler Geometry.
10/21/2015	University of Pennsylvania, Geometry and Topology Seminar.
11/25/2015	Université Paris-Sud, Séminaire Opérateurs de Dirac.
3/1/2016	Université de Québec à Montréal, Séminaire Géométrie et Topologie.
3/18/2016	Stony Brook University, AMS Sectional Meeting, Special Session on PDE methods in Geometric Flows.
3/19/2016	Stony Brook University, AMS Sectional Meeting, Special Session on Complex Geometric Analysis.
5/3/2016	Stony Brook University, Geometry/Topology Seminar.
5/5/2016	Columbia University, Complex Geometry and PDE Seminar.
5/27/2016	Harvard University, Center of Mathematical Sciences and Applications, Members' Seminar.
6/15/2016	Institut de Mathématiques de Toulouse, Recent Advances in Complex Geometry.
7/18/2016	Hayama Symposium on Several Complex Variables.
7/24/2016	University of Tokyo, Trends in Modern Geometry.
8/17/2016	American Institute of Mathematics, Workshop on Complex Monge-Ampère Equations.
10/8/2016	Virginia Tech, Workshop on the Mathematics and Physics of F-theory.
11/4/2016	University of Michigan, Geometry Seminar.
1/4/2017	Florida International University, Winter Conference on Geometry, Topology and Applications.
1/10/2017	Imperial College, London, Collapse, Adiabatic Limits, and Special Holonomy.
1/23/2017	Chalmers University, KASS seminar.
2/15/2017	Cambridge University, Algebraic Geometry Seminar.
2/27/2017	Chalmers University, KASS seminar.
4/24/2017	ICMS Edinburgh, Positivity in Algebraic and Complex Geometry.
5/2/2017	Harvard University, Conference Celebrating the 50th Anniversary of JDG.
5/15/2017	National University of Singapore, Complex Geometry, Dynamical Systems and Foliation Theory.
5/19/2017	Näss Fabriker, Nordan Conference on Complex Analysis.
6/8/2019	Institut Fourier, Grenoble, Conference in Honour of Jean-Pierre Demailly's 60th Birthday.
6/14/2017	Université Paris-Sud, Séminaire Opérateurs de Dirac.
7-5/2017	MFO Oberwolfach, Differentialgeometrie im Großen.
9/27/2017	Boston University, Geometry and Physics Seminar.
10/9/2017	University of Michigan, Complex Analysis, Dynamics, and Geometry Seminar.
11/1/2017	University of Illinois, Chicago, Algebraic Geometry seminar.
11/16/2017	University of Minnesota, Colloquium.
11/17/2017	Rutgers University, Geometric Analysis Conference.
11/27/2017	University of Wisconsin-Madison, Colloquium.
11/30/2017	University of California, San Diego, Colloquium.
12/4/2017	Notre Dame University, Colloquium.
12/7/2017	Northeastern University, Colloquium.
12/12/2017	University of North Carolina, Chapel Hill, Colloquium.

1/3/2018	University of Toronto, Colloquium.
1/8/2018	McGill University, Colloquium.
1/10/2018	Massachusetts Institute of Technology, Special Seminar.
1/17/2018	Michigan State University, Colloquium.
1/19/2018	Duke University, Colloquium.
2/8/2018	Columbia University, Complex Geometry and PDE seminar.
2/9/2018	Simons Foundation, Nonlinear Partial Differential Equations meeting.
3/3/2018	Vanderbilt University, Shanks Workshop on Complex Differential Geometry.
3/10/2018	Notre Dame University, Conference on Complex Geometry and Several Complex Variables.
3/12/2018	Centre de Recherches Mathematiques, Workshop on Geometric Analysis.
4/5/2018	Harvard University, Center of Mathematical Sciences and Applications, Simons Collaboration on Mirror Symmetry.
4/26/2018	University of New Mexico, Geometry and Algebra Seminar.
5/24/2018	Lehigh University, Geometry and Topology Conference.
5/29/2018	Hebrew University, Geometry and Topology Seminar.
8/14/2018	American Institute of Mathematics, Nonlinear PDEs in real and complex geometry.
11/15/2018	Columbia University, November 15, 2018, Complex Geometry and PDE seminar.
11/30/2018	University of British Columbia, Rising Star Lecture.
1/26/2019	UC San Diego, Southern California Geometric Analysis Seminar.
1/28/2019	UC Berkeley, Differential Geometry Seminar.
2/11/2019	Harvard University, Center of Mathematical Sciences and Applications, Mathematical Physics Seminar.
3/5/2019	Harvard University, Differential Geometry Seminar.
3/20/2019	Harvard University, Workshop on Mirror Symmetry and Stability.
4/2/2019	Maryland University, Geometric Analysis Seminar.
4/8/2019	Northwestern University, Analysis Seminar.
4/13/2019	University of Connecticut- Hartford, AMS Sectional Meeting, Special Session on Recent Developments in Geometric Analysis and PDEs.
4/27/2019	Howard University, Metro Area Differential Geometry Seminar.
5/3/2019	Harvard University, Differential Geometry, Calabi-Yau Theory, and General Relativity, in celebration of the 70th birthday of S.-T. Yau.
5/21/2019	Chalmers University, KASS seminar.
5/24/2019- 5/25/2019	Higher School of Economics, Moscow, Mini-course on PDE and stability in mirror symmetry.
5/29/2019	Higher School of Economics, Moscow, Who's who in mirror symmetry.
6/3/2019	Palazzone di Cortona, Current developments in complex and analytic geometry.
10/31/2019	Banff International Research Station, Bridging the Gap between Kähler and non-Kähler Complex Geometry.
11/12/2019	University of Chicago, Geometric Analysis Seminar.
11/14/2019	Simons Foundation, Collaboration on Homological Mirror Symmetry Annual Meeting.
11/20/2019	Princeton University, Geometric Analysis Seminar.
3/5/2020	Columbia University, Complex Geometry and PDE seminar.

4/29/2020	Université Paris-Sud, Séminaire Opérateurs de Dirac (online)
9/29/2020	CUHK- Harvard-YMSC joint Differential Geometry Seminar (online)
9/31/2019	Simons Workshop on Floer and algebro-geometric aspects of SYZ mirror symmetry (online)
10/20/2020	Geometria em Lisboa (online)
11/9/2020	Indian Institute of Science, Geometric Analysis Seminar (online)
11/11/2020	Instituto de Ciencias Matemáticas (ICMAT), Geometry Seminar (online)
12/8/2020	American Institute of Mathematics, Stability in Mirror Symmetry (online)
3/1/2021	Jagiellonian University, Seminar on Complex analysis and Elliptic PDE's (online)
4/24/2021	Stony Brook University, Geometry Festival (online)
9/12/2021	Simons Collaboration on Special Holonomy: Progress and Open Problems (online).
10/12/2021	Tsinghua University, Chern: A great geometer of the 20th century (online).
10/18/2021	UT Dallas, Geometry, Topology, and Dynamical Systems Seminar (online).
11/12/2021	Yale, Geometric Analysis Seminar (online).
11/19/2021	Centre de Recherches Mathematiques, Colloquium (online).
12/5/2021	Canadian Mathematical Society, Winter Meeting, Special Session on Recent Developments in Complex Geometry and Geometric Analysis (online).
12/11/2021	Vanderbilt University, Shanks Workshop on Complex Geometry.
3/29/2022	Zoom Algebraic Geometry Seminar (online).
4/5/2022	Northwestern-UIC Complex Geometry Seminar.
5/3/2022	Columbia University, Deformations of Geometric Structures: a conference in honor of Masatake Kuranishi.
5/3/2022	Beijing International Center for Mathematical Research, Geometric Analysis Seminar (online).
7/15/2022	Simons Center for Geometry and Physics, Forty Years of Ricci Flow: The Geometric-Flow Revolution in Global Differential Geometry (online).
9/22/2022	Columbia University, Complex Geometry and PDE seminar (online).
10/5/2022	Yau Mathematical Sciences Center, Algebraic Geometry Seminar (online).

Teaching Talks

3/10/21	Abdul Latif Jameel World Education Lab, Education Experiments Webinar Series (online).
12/1/2021	MIT Open Learning, xTalk Series, Slack in Education: a conversation with colleagues (online).

Teaching Experience

- **Massachusetts Institute of Technology**
  - 18.03 Differential Equations (F20, S22)
  - 18.965 Geometry of Manifolds I (F19)
  - 18.966 Geometry of Manifolds II (S19)
  - 18.103 Fourier Analysis: Theory and Applications (F18)

- **Harvard University:**
  - Math 263: Analytic Techniques in Algebraic Geometry (F16)
  - Math 230a: Differential Geometry (F16, F17)
  - Math 264: Nonlinear Elliptic PDEs (S16)
  - Math 262: The Geometry of the Complex Monge-Ampère Equation, (S15)
  - Math 112: Introductory Real Analysis (S15, S16)
  - Math 136: Differential Geometry of Curves and Surfaces (F14, F15, F17)

- **Columbia University**
  - Ordinary Differential Equations (Sum12, Sum13, Sum14)

Service

- **Scientific Service**:
  - Conference and Seminar Organization
    - Organizer: Geometry and Analysis Seminar for Boston Area Graduate Students, Annual
    - Co-organizer: Conference on Deformations of Geometric Structures in Current Mathematics, May, 2022
    - Co-organizer: Workshop on Stability in Mirror Symmetry, American Institute of Mathematics, December 2020 (Online), April 2022
    - Organizer: Virtual Learning Seminar on Lagrangian Mean Curvature Flow, 2021 - present
    - Organizer: MIT Graduate Student Lunch Seminar, 2019
    - Co-organizer of the Harvard Center of Mathematical Sciences and Applications Colloquium, Spring 2018
    - Co-organizer of the Minischool on Nonlinear Equations, December, 2016 Harvard University
    - Co-organizer of the Differential Geometry Seminar, 2016–2018, Harvard University
    - Co-organizer of the Conference on Nonlinear Equations, April, 2016, Harvard University
    - Co-organizer of the Geometric Analysis seminar, 2015-2016, Harvard University
    - Co-organizer of the Evolution Equations seminar, 2015-2016, Harvard University
    - Co-organizer of the Special Day on Geometry and PDE, October, 2013, Columbia University
    - Co-organizer of the Informal Complex Geometry and PDE Seminar, Columbia University, 2012-2014
    - Organizer of the Graduate Student Geometric Analysis Seminar, Columbia University, 2011-2013
  - Editor, Pure and Applied Mathematics Quarterly
  - Editor (with L. Bieri, P. T. Chruściel, and S.-T. Yau), Nonlinear Analysis in Geometry and Applied Mathematics, Part 2, International Press, 2018
  - Panelist, National Science Foundation: Geometric Analysis Section
  - Proposal Reviewer, Banff International Research Station
  - Proposal Reviewer, Polish National Science Centre
  - Proposal Reviewer, Israeli Science Foundation
  - Referee: Journal of the American Mathematical Society, Annals of Mathematics, Acta Mathematica, Inventiones Mathematicae, Duke Mathematical Journal, Annals of PDE, Journal of Differential Geometry, Journal of the European Mathematical Society, and many others

- **Departmental Service at MIT:**
  - Postdoctoral Researchers Supervised:
    - Li, Yang, 2020 - current, CLE Moore Instructor
  - Undergraduate Research Students Supervised:
    - Echániz, Samuel Muñoz (MIT, UROP, Spring 2020); current position: PhD Candidate in Mathematics, Cambridge University
    - Padilla, Erick (MIT, UROP, Fall 2022): currently working on ADHM construction
    - Firester, Benjamin (Harvard, class of 2023): supervised research project since Fall 2019: resulting in Goldwater Scholarship.
  - Independent Study Supervision (D. Darrow, 2019-2020)
  - Graduate Student Admissions Committee, 2018 – present
  - Post-doctoral Hiring Committee, 2018– present
  - MIT Thesis Defense Committees: Nick Strehlke, Jiewon Park, Ao Sun
  - MIT Qualifying Exam Committee: Xinrui Zhao, Tang-Kai Lee, Catherine Wolfram, Arun Kannan, Alexander Ortiz, Matthew Nicoletti, Deeparaj Bhat, Pu Yu, Ishaan Levy, Feng Gui, Shengwen Gan

- **Departmental Service at Harvard:**
  - Undergraduate Research Students Supervised:
    - Eisenberg, Or
    - Hallas, Christian
    - McNamara, Jacob
  - B.Sc. Student Thesis Supervised:
    - Jiradilok, Pakawut (Harvard, class of 2017): Current position: recent PhD in Mathematics from MIT, continuing at MIT as a Postdoc Associate.