Leonardo Francisco Cavenaghi

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Research Profile & Specialties

My research examines how symmetries, deformations, and quantum–Hodge structures govern the classification of geometric spaces across birational, symplectic, and differential geometry.

- **Algebraic & Birational Geometry, Hodge Theory, and the Theory of Atoms:** Hodge atoms, G-equivariant and Chen–Ruan orbifold atoms, non-Archimedean Frobenius manifolds (F-bundles), quantum cohomology and quantum connections, Gromov–Witten theory, and rationality obstructions for Fano fourfolds, complete intersections in flag varieties, and conic bundles (Shokurov's conjecture).
- **Computational Quantum Cohomology & GEOATOMS:** Contributor to **GEOATOMS** (`atomicdecompositions`), an open computational catalogue and Python/SageMath suite (`gwflags`, `gwtoric`, `gwapp`) for exact virtual localization in genus-zero Gromov–Witten theory and small quantum multiplication $c_1(TX)\star$.
- **Symplectic Geometry, Mirror Symmetry & Mathematical Physics:** Non-Kähler SYZ mirror symmetry for solvmanifolds, generalized complex structures and generalized Dolbeault/Bott–Chern/Aeppli cohomologies on almost abelian solvmanifolds, spherical T-duality via $\star$-diagrams and generalized logarithmic transformations, and exotic Lorentzian spacetimes.
- **Differential Geometry & Geometric Analysis:** Cheeger deformations and convex sums of metrics, fat Riemannian submersions, weakly nonnegative curvature (WNN), A-Clifford / 3-Sasakian rigidity, symmetric spaces as adjoint orbits, singular Riemannian foliations and symmetric criticality, homogeneous Ricci flow on $\mathrm{SU}(3)/\mathrm{T}^2$, and the G-equivariant Kazdan–Warner problem.

Academic Appointments

Established Researcher (R3), ICMS-Sofia / IMI–BAS, Sofia, Bulgaria 2024–present
Researcher in the *Theory of Atoms* group (formal R3 contract at IMI–BAS since July 2025), working on Hodge atoms, equivariant and orbifold birational invariants, quantum connections, and **GEOATOMS**.

Postdoctoral Researcher / Visiting Research Fellow (FAPESP–BEPE), University of Miami / IMSA, USA 2024–2025
Research on the Theory of Atoms, G-equivariant birational geometry, and spherical T-duality; host: Ludmil Katzarkov.

Postdoctoral Fellow (FAPESP & CAPES), IMECC–UNICAMP, Campinas, Brazil 2022–2025
Postdoctoral research at the Department of Mathematics, hosted by Lino Grama (FAPESP fellowship `2022/09603-9`).

Postdoctoral Researcher (SNSF / DFG SPP 2026), University of Fribourg, Switzerland 2021–2022
DFG/SNSF Priority Programme SPP 2026 *Geometry at Infinity*; host: Anand Dessai.

Education

Ph.D. in Mathematics, University of São Paulo (IME–USP), Brazil 2018–2020
Thesis: *Deformações métricas e aplicações* (*Metric Deformations and Applications*). Advisor: Llohann Dallagnol Sperança; co-advisor: Marcos Martins Alexandrino da Silva.

M.Sc. in Mathematics, University of Campinas (IMECC–UNICAMP), Brazil 2016–2018
Dissertation: *O Teorema de Calabi–Yau via fluxos de Ricci* (*The Calabi–Yau Theorem via Ricci Flows*). Advisor: Rafael de Freitas Leão.

B.Sc. in Mathematics, University of Campinas (IMECC–UNICAMP), Brazil 2012–2015

Prizes & Distinctions

- **2024/2025: Distinguished Paper Award** (*Collectanea Mathematica*), awarded by the Editorial Board for *"Positive Ricci curvature through Cheeger deformations"* (*Collect. Math.* 75 (2024), 481–510).
- **2024: Honorable Mention (*Mención Destacada*), IMSA–AMC Young Scientist Prize** (José Adem Committee 2024), awarded jointly by IMSA (University of Miami) and the Mexican Academy of Sciences.
- **2021: CAPES Thesis Award** (*Prêmio CAPES de Tese 2021*), best doctoral thesis defended in Brazil in

2020 in Mathematics, Probability, and Statistics.

- **2021: Professor Carlos Teobaldo Gutiérrez Vidalon Thesis Prize**, awarded by ICMC–USP and the Brazilian Mathematical Society (SBM) for the best doctoral thesis in pure mathematics defended in Brazil in 2020.

Published Journal Articles (12)

1. **L. F. Cavenaghi, L. Grama, L. Katzarkov**
A geometric realization of spherical T-duality via $\star$-diagrams.
Advances in Mathematics 503 (2026), 111202. doi:10.1016/j.aim.2026.111202 | arXiv:2404.19088.

2. **M. M. Alexandrino, L. F. Cavenaghi, D. Corro, M. K. Inagaki**
Singular Riemannian foliations, variational problems and principles of symmetric criticalities.
Annali di Matematica Pura ed Applicata 205, no. 5 (2026), 2507–2572. doi:10.1007/s10231-026-01679-z | arXiv:2311.07058.

3. **L. F. Cavenaghi, L. Grama**
A curvature approach to fatness.
International Journal of Mathematics 37, nos. 5–6 (2026), 2542001. doi:10.1142/S0129167X25420017 | arXiv:2212.08154.

4. **L. F. Cavenaghi, J. M. do Ó, L. D. Sperança**
Hearing exotic smooth structures.
Advanced Nonlinear Studies 25, no. 4 (2025), 1112–1126. doi:10.1515/ans-2023-0151 | arXiv:2402.10106.

5. **L. F. Cavenaghi, L. Grama**
Gromoll–Meyer's actions and the geometry of (exotic) spacetimes.
Differential Geometry and its Applications 94 (2024), 102121. doi:10.1016/j.difgeo.2024.102121 | arXiv:2403.08960.

6. **L. F. Cavenaghi, C. Garcia, L. Grama, L. A. B. San Martin**
Symmetric spaces as adjoint orbits and their geometries.
Revista Matemática Complutense 37, no. 3 (2024), 921–966. doi:10.1007/s13163-024-00486-5 | arXiv:2302.09638.

7. **L. F. Cavenaghi, L. Grama, R. M. Martins**
On the dynamics of positively curved metrics on $\mathrm{SU}(3)/\mathrm{T}^2$ *under the homogeneous Ricci flow.*
Matemática Contemporânea 60 (2024), 3–30. doi:10.21711/231766362024/rmc602 | arXiv:2305.06119.

8. **L. F. Cavenaghi, R. J. M. e Silva, L. D. Sperança**
Positive Ricci curvature through Cheeger deformations.
Collectanea Mathematica 75, no. 2 (2024), 481–510 (*2024 Distinguished Paper Award*). doi:10.1007/s13348-023-00396-7 | arXiv:1810.09725.

9. **L. F. Cavenaghi, L. Grama, L. D. Sperança**
The concept of Cheeger deformations on fiber bundles with compact structure group.
São Paulo Journal of Mathematical Sciences 17, no. 2 (2023), 441–464. doi:10.1007/s40863-022-00343-7 | arXiv:1801.06576.

10. **L. F. Cavenaghi, L. D. Sperança**
Positive Ricci curvature on fiber bundles with compact structure group.
Advances in Geometry 22, no. 1 (2022), 95–104. doi:10.1515/advgeom-2021-0007 | arXiv:1911.03608.

11. **M. M. Alexandrino, L. F. Cavenaghi, I. Gonçalves**
On mean curvature flow of singular Riemannian foliations: Noncompact cases.
Differential Geometry and its Applications 72 (2020), 101664. doi:10.1016/j.difgeo.2020.101664 | arXiv:1909.04201.

12. **L. F. Cavenaghi, L. D. Sperança**
On the geometry of some equivariantly related manifolds.
International Mathematics Research Notices (IMRN) 2020, no. 23 (2020), 9730–9768. doi:10.1093/imrn/rny268 | arXiv:1708.07541.

Accepted Contributions (1)

13. **L. F. Cavenaghi, G. Galindo, L. D. Sperança**
The curvature of convex sum of metrics and applications.
Accepted for publication in **Differential Geometry in Latin America 2025**. arXiv:2106.14781.

Preprints & Submitted Manuscripts (14)

1. **L. F. Cavenaghi, L. Katzarkov, D. Pomerleano, Z. Zhang**
An atomic approach to Shokurov's conic-bundle conjecture.
2026. arXiv:2610.41174.

2. **M. de Andrade Pinto, L. C. B. Maia, L. F. Cavenaghi, P. A. Muniz Martins**
On the generalized cohomologies of almost abelian solvmanifolds.
2026. arXiv:2610.20153.

3. **L. Carazolli, L. F. Cavenaghi, L. Katzarkov, M. Kontsevich, P. A. Muniz Martins**
A quantum connection approach to rationality.
2026. arXiv:2610.06669.

4. **B. Alexeev, L. F. Cavenaghi, G. Galindo, B. Georgiev, L. Katzarkov, P. A. Muniz Martins**
On the atomic decomposition of complete intersection in flag varieties.
2026. arXiv:2609.21914.

5. **M. de Andrade Pinto, L. C. B. Maia, L. F. Cavenaghi, P. A. Muniz Martins**
On the generalized geometry of almost abelian solvmanifolds.
2026. arXiv:2609.00254.

6. **L. F. Cavenaghi, L. Grama, L. Katzarkov, P. A. Muniz Martins**
The Cohomology of Solvmanifold SYZ Mirrors.
2026. arXiv:2604.19303.

7. **L. F. Cavenaghi, L. Katzarkov, M. Kontsevich**
Atoms meet symbols.
2025; revised 2026. arXiv:2509.15831.

8. **L. F. Cavenaghi, L. Grama, L. Katzarkov**
A Gromov–Witten approach to G-equivariant birational invariants.
2024; revised 2025. arXiv:2405.07322.

9. **L. F. Cavenaghi, L. Grama, R. M. Martins, D. D. Novaes**
The complete dynamics description of positively curved metrics in the Wallach flag manifold $\mathrm{SU}(3)/\mathrm{T}^2$.
2023. arXiv:2307.06418.

10. **L. F. Cavenaghi, L. Grama, L. D. Sperança**
Fatness and positive curvatures on Riemannian submersions.
2022; revised 2026. arXiv:2207.10749.

11. **L. F. Cavenaghi**
A note on the vertizontal curvature of fat bundles.
2022; revised 2024. arXiv:2207.10757.

12. **M. M. Alexandrino, L. F. Cavenaghi**
Singular Riemannian foliations and the prescribing scalar curvature problem.
2021. arXiv:2111.13257.

13. **L. F. Cavenaghi, J. M. do Ó, L. D. Sperança**
The G-equivariant Kazdan–Warner problem.
2021; revised 2026. arXiv:2106.14709.

14. **L. F. Cavenaghi, L. D. Sperança**
A direct approach to prescribing scalar curvature on bundles.
2020; revised 2023. arXiv:2012.13272.

Monographs & Manuscripts in Preparation

- **L. F. Cavenaghi, L. Katzarkov, M. Kontsevich**, $9\frac{1}{2}$ *lectures in atom theory* (in preparation, 2026).
- **D. Auroux, L. F. Cavenaghi, L. Grama, L. Katzarkov**, *Mirror symmetry for homotopy Hopf manifolds* (in preparation, 2026).

Open-Source Research Software & Computational Infrastructure

- **GEOATOMS — Quantum Cohomology & Atomic Decompositions Platform** (leonardofcavenaghi.github.io/atomicdecompositions, GitHub: `leonardofcavenaghi/atomicdecompositions`): Open computational library, web GUI, CLI, and catalogue of 131+ symbolic quantum cohomology computations for flag varieties, toric varieties, and supported complete intersections (`gwflags`, `gwtoric`, `gwapp`).

Minicourses & Lecture Series

- **July 2027 (Forthcoming):** *The A-model F-bundle, Euler decomposition, and Hodge atoms* (Week 1 Foundations Lecturer & Co-organizer), *5th Simons Math Summer Workshop: New Developments in Birational Geometry*, SCGP, Stony Brook University, USA.
- **Dec 2026:** Minicourse Lecturer, *Hodge Theory and Birational Geometry 2026*, ICMS-Sofia / IMI–BAS, Bulgaria.
- **Oct 2026:** *Berkovich Geometry, the A-Model F-Bundle, and Decomposition Theorems for F-Bundles and Hodge Atoms* (3-lecture minicourse), Workshop *Fundamentals for the Theory of Atoms and Related Topics*, SCGP, Stony Brook University, USA.
- **June 2026:** *Atom theory from scratch and recent developments* (2-part minicourse), KU Leuven, Belgium.
- **Jan 2026:** *Short Course on Atoms: G-equivariant atoms (and symbols)*, Homological Mirror Symmetry Conference, IMSA, University of Miami, USA.
- **Nov 2025:** *Atoms, G-equivariant atoms, and Chen–Ruan atoms* (2-lecture series), IASM, Zhejiang University, Hangzhou, China.
- **Sept–Nov 2025:** *Theory of Atoms via Examples*, weekly graduate lecture series, ICMS-Sofia / IMI–BAS, Bulgaria.
- **May–June 2025:** *Atoms' Theory via Examples*, 12-lecture graduate course across 6 weeks, IMECC–UNICAMP, Campinas, Brazil.
- **Feb–Mar 2022:** *Metric Deformations and Applications*, 6-lecture graduate summer minicourse, IME–USP, São Paulo, Brazil.

Selected Invited Talks & Conference Presentations (2018–2026)

- **Dec 2026:** *Homotopy Hopf manifolds, logarithmic transformations, and mirror symmetry* (2-part seminar), IMECC–UNICAMP, Brazil.
- **Nov 2026:** *On the atomic decomposition of some complete intersections*, Algebra, Geometry & Topology Seminar, ISTA, Austria.
- **Oct 2026:** *OpenAI's disproof of Kuznetsov's conjecture*, Symposium *Math, Physics, and AI: 200 Years Later*, SCGP, Stony Brook, USA.
- **Oct 2026:** *On the atomic decomposition of some complete intersections*, Birational Geometry Seminar, UCLA (Online).
- **Oct 2026:** *A quantum connection approach to rationality*, *Fundamentals for the Theory of Atoms*, SCGP, Stony Brook, USA.
- **Aug 2026:** *G-equivariant atoms: present and future*, *Recent Developments in Geometry*, Burgas, Bulgaria.
- **Aug 2026:** *Spherical T-duality meets $\star$-diagrams* & *On the geometry of some equivariantly related smooth manifolds*, *Celebrating the Consortium IMSAC*, ICMS-Sofia, Bulgaria.
- **July 2026:** *Atoms and numerology*, *1st Future Stars Annual Meeting of the Simons Foundation*, University of Pennsylvania, Philadelphia, USA.
- **May 2026:** *Recent progresses in the theory of atoms / G-equivariant atoms*, Plenary talks at *Hodge Theory, Birational Geometry and Atoms*, IMSA Miami (USA) and IMPA Rio de Janeiro (Brazil), and *Equivariant Birational Geometry Workshop*, IMSA Miami.
- **Apr 2026:** *Equivariant Atoms* & *Operadic WDVV equations / Intro to Atoms*, *Atoms, Hodge Theory and MMP*, ICMS-Sofia, Bulgaria.
- **Jan–Feb 2026:** *Torus actions on the moduli space of stable maps and GKM varieties* (*New Miami Mathematical Waves*); *G-equivariant Hodge atoms (and symbols)* (*HMS Conference*); *How to fill out dual patterns out of stripped fabrics* (*HMS Postconference*), IMSA, University of Miami, USA.
- **2025:** Invited talks at *December Workshop on Atom Theory* (ICMS-Sofia, 3 talks); *New Developments in Singularity Theory* (IMSA Miami, 2 talks); *ICMS-Sofia Seminar* (*F-bundles, Hodge atoms, and applications*); *Geometry at Large* (Burgas, *Nearby Lagrangian conjecture and homotopy spheres*); *Celebrating the Consortium IMSAC* (Sofia); *SIMIS String Math Seminar* (Shanghai); *Theory of Atoms Seminar* & *Symplectic Geometry Seminar* (ICMS-Sofia); *Geometry Seminar* (ICMC–USP); *Geometry at Large* (ICMAT Madrid); *Lefschetz Centennial Colloquium*, *HMS Conference* & *Birational Geometry Conference* (IMSA Miami, *Atoms meet symbols*).
- **2024:** Invited talks at *December Workshop on Birational Geometry and Atoms* (ICMS-Sofia/IMSA); *1st José Adem AMC–IMSA Prize Symposium* (El Colegio Nacional, Mexico City); *Geometry Webinar AmSur/AmSul*; *Complex Geometry at Large* (Sunny Beach, Bulgaria); *IMSAC Days in Sofia*; *IMSA Geometry Conference* (University of Miami, *Hodge structures on 8-dimension Homotopy Hopf manifolds*).
- **2023:** Invited talks at *50 Years of Nigel Hitchin's Mathematics* (IMSA Miami); *Elliptic Genera, Spectra and*

Generalized Geometry (IMSA Miami); *EMAp–FGV Seminar* (Rio de Janeiro); *Virtual Seminar on Geometry with Symmetries*; *Quantum Toric Geometry, Generalized Geometries and O-Minimality* (IMSA Miami); *17th Young Researchers Workshop* (KU Leuven, Belgium); *Summer Math Program* (UFCG, Brazil).

- **2018–2022:** Invited talks at *Topology-Geometry Seminar* (University of Oregon); *Workshop on Geometry of Spaces with Curvature Bounds*; *Workshop GS&MS* (Univ. Nacional de Córdoba, Argentina); *UFC & UFPB* Geometric Analysis Seminars; *Summer Workshops in Mathematics* (Univ. of Brasília, 2021 & 2022); *Geometry Webinar AmSur/AmSul* (2021); *IMPA Geometry Seminar* (2021); *AFriKa Seminar* (Fribourg/KIT, 2021); *UFSCar Colloquium* (2021); *UFABC Seminar* (2021); *Symmetry and Shape* (Santiago de Compostela, 2019); *Oberseminar Differentialgeometrie* (Univ. of Cologne, 2019); *IME–USP & IMECC–UNICAMP* Geometry Seminars.

Conference Organization, Teaching, Mentoring & Service

- **Conference Organization:** Co-organizer of *5th Simons Math Summer Workshop: New Developments in Birational Geometry* (SCGP Stony Brook, July 2027); *Hodge Theory and Birational Geometry 2026* (ICMS-Sofia, Dec 2026); *Fundamentals for the Theory of Atoms and Related Topics* (SCGP Stony Brook, Oct 2026); *Future Stars: Annual Meeting of the Simons Foundation* (UPenn, July 2026); *Hodge Theory, Birational Geometry and Atoms* (IMSA–UNICAMP–IMPA series, May 2026); *New Developments in Singularity Theory* (IMSA Miami, Nov 2025).
- **University Teaching:** Graduate lecturer for *Topics in Geometric Analysis* (IMECC–UNICAMP, 2022); Undergraduate lecturer for *Complex Lie Algebras* and *Free Seminar* (University of Fribourg, 2021).
- **Mentoring & Co-Advising:** M.Sc. co-advisor (with Lino Grama) of Luiz Otávio Carazolli at IMECC–UNICAMP (orbifold Gromov–Witten theory and quantum connections); active mentoring of postdoctoral fellows and graduate researchers in the Sofia–Campinas–Miami Theory of Atoms network (G. Galindo, P. A. Muniz Martins, M. de Andrade Pinto, L. C. B. Maia).
- **Refereeing & Reviewing:** Reviewer for *SIGMA*, *Illinois Journal of Mathematics*, *São Paulo Journal of Mathematical Sciences*, *MathSciNet* (AMS), *zbMATH Open*, *SpringerBriefs in Mathematics*, *Trends in Computational and Applied Mathematics*, *Journal of Applied Statistics*, and grant evaluator for *Programa Centelha* (FAPESP/CONFAP).

Research Grants & Fellowships

- **2024–present:** ICMS-Sofia / Simons Foundation / IMI–BAS research support (Established Researcher R3).
- **2024:** FAPESP Research Internship Abroad (BEPE), grant `2023/14316-1` (University of Miami / IMSA).
- **2022–2025:** FAPESP Postdoctoral Fellowship, grant `2022/09603-9`, and CAPES Postdoctoral Fellowship (IMECC–UNICAMP).
- **2021–2022:** SNSF / DFG Priority Programme SPP 2026 Postdoctoral Fellowship (University of Fribourg, Switzerland).
- **2018–2020:** FAPESP Doctoral Fellowship, grant `2017/24680-1` (IME–USP).