

## **Unit Name**

Qubits and Spacetime Unit  
Associate Professor Philipp A Hoehn

## **Collaborations**

ChunJun Cao, Virginia Tech, USA, Squeezing Codes by Squeezing Quantum Reference Frames  
Markus Frembs, U Hannover, Germany, Informational complementarity relations  
Sylvain Carrozza, U Dijon, France, A correspondence between quantum error correcting codes and quantum reference frames  
Jesse Woods, U Bern, Switzerland, Soft edges for Yang-Mills theory  
Vanessa Brzic, Sorbonne U, France, Resolution of gauge ambiguities in cavity QED  
Germain Tobar, U Stockholm, Sweden, Resolution of gauge ambiguities in cavity QED  
Renata Ferrero, FAU Erlangen, Germany, Relational RG  
Ana Belen Sainz; John Selby, Gdańsk University, Poland, Quantum Foundations and Contextuality  
Aidan Chatwin-Davies, U Rhode Island, USA, A correspondence between quantum error correcting codes and quantum reference frames  
Masazumi Honda, RIKEN iTems, Japan, Quantum error correction and gauge theory  
Josh Kirklin, Perimeter Institute, Canada, Microcausality in QED  
Artur Tsoibanjan, Hollins University, USA, A pentagon of QRFs  
Fabio Mele, U Western Ontario, Canada, A correspondence between quantum error correcting codes and quantum reference frames  
Anna Pachol, University of South-Eastern Norway, Norway, Mathematics, Physics, Quantum, mathematical/theoretical physics, Quantum Gravity  
Chris Wever, Bosch quantum computing, Germany, Informational complementarity relations  
Giovanni Natale, Informational complementarity relations  
Sylvain Carrozza, U Dijon, France, Fluctuation relations in field theory

## **Research Personnel**

Francisco Sartini, Postdoctoral Scholar  
Goncalo Araujo Regado, Postdoctoral Scholar  
Bilyana Tomova, Postdoctoral Scholar  
Luca Marchetti, Postdoctoral Scholar  
Sergio Ernesto Aguilar Gutierrez, Postdoctoral Scholar  
Stefan Eccles, Postdoctoral Scholar, Moving to Penn State as a postdoc in August 2025  
Julian De Vuyst, PhD Student  
Javier Pagan Lacambra, PhD Student  
Samuel Paul Pickup, Research Intern

Luca Ciceri, Research Intern  
Jakob Steck, Research Intern  
Olamide Olabode Odutola, Research Intern  
Germain Solomon Tobar, Visiting Research Student

### **Scholarly Contributions and Creative Productions (by Faculty)**

#### **Journal Article**

1. De, V. J.; Eccles, S.; Höhn, P. A.; Kirklin, J.  
Crossed Products and Quantum Reference Frames: On the Observer-Dependence of Gravitational Entropy. *Journal of High Energy Physics* 2025, 2025, 63.
2. Araujo-Regado, G.; Höhn, P. A.; Sartini, F.; Tomova, B.  
Soft Edges: The Many Links between Soft and Edge Modes. *Journal of High Energy Physics* 2025, 2025, 180.
3. De, V. J.; Eccles, S.; Höhn, P. A.; Kirklin, J.  
Gravitational Entropy Is Observer-Dependent. *Journal of High Energy Physics* 2025, 2025, 146.
4. De, V., Julian; Eccles, S.; Höhn, P. A.; Kirklin, J.  
Linearization (in)stabilities and Crossed Products. *Journal of High Energy Physics* 2025, 2025, 211.

#### **Presentation at Conference**

1. Hoehn, P. A.  
Gravitational Algebras, Entropies and Quantum Reference Frames. Observables in quantum gravity: from theory to experiment 2025.  
<https://indico.global/event/1376/>

#### **Seminars**

1. Hoehn, P. A.  
Gravitational Algebras, Entropies and Quantum Reference Frames. 2025.  
Invited seminar of the working group 3 of the COST Action Relativistic Quantum Information
2. Hoehn, P. A.  
Linking Quantum Error Correction and Gauge Theories with Quantum Reference Frames. 2025.  
<https://www.youtube.com/watch?v=CEukTZK1rZM&t=652s>  
Invited seminar of the Quantum error correction group at National University of Singapore (NUS)
3. Hoehn, P. A.  
Linking Quantum Error Correction and Gauge Theories via Quantum Reference Frames. 2025.
4. Hoehn, P. A.  
Linking Quantum Error Correcting Codes and Gauge Theories via Quantum Reference Frames. 2025.  
invited seminar
5. Hoehn, P. A.  
A Correspondence between Quantum Error Correcting Codes and Quantum Reference Frames. 2025.  
Invited seminar of the Quantum Information group (Renner group)
6. Hoehn, P. A.  
Gravitational Algebras, Entropies and Quantum Reference Frames. 2025.  
<https://relativity.phys.lsu.edu/ilqgs/>  
Invited seminar for the international LQG community (many groups tune in)
7. Hoehn, P. A.

An Introduction to Quantum Reference Frames and Their Application in Gauge Theory and Gravity. 2025.

Invited two-hour introductory lecture by EPFL and CERN on the the quantum reference frame approach developed by the unit.

8. Hoehn, P. A.

Observables and Dynamical Frames in Gravity. 2025.

Invited APEC Seminar

9. Hoehn, P. A.

(Quantum) Frame Covariance in Gauge Systems and Gravity . 2021.

<https://www.youtube.com/watch?v=tlI3p-ipdlo&t=1s>

Invited seminar

### **Scholarly Contributions (by Unit Members)**

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Joshua Kirklin	Journal Article	Emergent classical gauge symmetry from quantum entanglement	arXiv		2025
Aidan Chatwin-Davies	Journal Article	Holographic screen sequestration	Phys.Rev.D	APS	2024
Stefan Eccles	Journal Article	Why ETH: on thermalization and locality	arXiv preprint		2025
Sergio Ernesto Aguilar Gutierrez	Journal Article	TTbar deformations from AdS2 to dS2	JHEP	Springer	2025
Markus Frembs	Journal Article	Coming full circle -- A unified framework for Kochen-Specker contextuality	arXiv		2025
Sergio Ernesto Aguilar Gutierrez	Poster Presentation at Conference	T2 deformations in the double-scaled SYK model: Stretched horizon thermodynamics	Quantum Extreme Universe: Matter, Information, and Gravity (ExU-OIST)		2024
Julian De Vuyst	Poster Presentation at Conference	Gravitational entropy is observer-dependent	The 3rd young researchers' workshop of the Extreme Universe Collaboration & The 6th "Extreme Universe" School		2025
Stefan Eccles	Poster Presentation at Conference	Linearization (in)stabilities and crossed products	Observables in Quantum Gravity: From Theory to Experiment		2025
Julian De Vuyst	Poster Presentation at Conference	Gravitational entropy is observer-dependent	Observables in Quantum Gravity: From Theory to Experiment		2025
Sergio Ernesto Aguilar Gutierrez	Presentation at Conference	Probes of wormhole dynamics with matter from the double-scaled SYK in Krylov space	Recent Developments in Black Holes and Quantum Gravity		2025
Sergio Ernesto	Presentation at Conference	T2 deformations in the double-scaled SYK model:	Strings 2025, NYU Abu Dhabi		2025

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Aguilar Gutierrez		Stretched horizon thermodynamics			
Markus Frembs	Presentation at Conference	A new perspective on Kochen-Specker contextuality	Coogee'25	Coogee Bay Hotel, Sydney	2025
Fabio Maria Mele	Presentation at Conference	The perspective-neutral approach to dynamical frame covariance	UWO Group Seminar (Part I)	Western University	2025
Fabio Maria Mele	Presentation at Conference	Linking quantum error correction and gauge theory via quantum reference frames	UWO Group Seminar (Part II)	Western University	2025
Luca Marchetti	Presentation at Conference	Emergent Cosmology from Quantum Gravity	Kashiwa-no-ha Dark Matter and Cosmology Symposium		2024
Fabio Maria Mele	Presentation at Conference	Quantum Reference Frames and Relativity of Subsystems	Workshop Recent developments in Mathematical Physics	University of Naples (IT)	2022
Fabio Maria Mele	Seminars	A correspondence between quantum error correcting codes and quantum reference frames	Saclay QFoundations Seminar	Paris, France	2025
Markus Frembs	Seminars	A new perspective on Kochen-Specker contextuality	Algebraic Structures in Quantum Computing 2025	Leibniz University Hannover	2025
Fabio Maria Mele	Seminars	A correspondence between quantum error correcting codes and quantum reference frames	Louisiana State University (USA)		2025
Luca Marchetti	Seminars	Quantum Gravity and Emergent Cosmology: A Group Field Theory Perspective	Joint APEC-MS Seminar, Kavli IPMU		2025

### ***Honors, Awards & Fellowships***

Term 1 2025 - Term 3 2028	Co-PI of "WithOut SpaceTime (WOST)", 2025, Templeton Foundation, 2025, Templeton Foundation [Fiscal Year: 2025-12-01]
Term 2 2022 - Term 3 2025	Co-Principal Investigator (co-PI) for Phase 2 of "The Quantum Information Structure of Spacetime (QISS)", 2022, Templeton Foundation [Fiscal Year: 2022-01-01]

### ***Honors, Awards & Fellowships [By Unit Members Only]***

Term 2 2025 - Term 2 2025	Julian De Vuyst, IOP Outstanding Reviewer Award 2024, IOP 抜群査読賞 2024, 2025, Institute of Physics (IOP), 毎年、IOP Publishingの編集者は、レビューの質、量、適時性に基づいて、優れたレビュアーを選出しています。 [Fiscal Year: 2025-03-01]
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### External Service

Term 2 2025 - Ongoing	Walter-Benjamin-Programm: Evaluator for Individual Postdoctoral Fellowships, Deutsche Forschungsgesellschaft (DFG), Grant application evaluator [Fiscal Year: 2023]
Term 3 2021 - Term 2 2025	Editor, New Journal of Physics, Terminated by editorial board membership to focus more on research [Fiscal Year: 2021-2025]

### Outreach Activities [For Unit Members Only]

Term 2 2025	Julian De Vuyst, Science Challenge - Final Presentation Preparation, OIST [Fiscal Year: 2025-03-18]
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### Workshops and Seminars [Organized and Hosted by Faculty/Units]

Speaker Name(s)	Title	Location	Co-Organizers	Date
22 invited speakers: Shadi Ali Ahmad (NYU) Caslav Brukner (IQOQI Vienna) Anne-Catherine de la Hamette (IQOQI Vienna-ETH Zurich) Stefan Eccles (Penn State) Laurent Freidel (Perimeter) Thomas Galley (IQOQI Vienna) Flaminia Giacomini* (ETH Zurich-Rome Tor Vergata) Steve Giddings (UCSB) Kristina Giesel (FAU Erlangen) Jan Glowacki (IQOQI Vienna) Henrique Gomes (Oxford) Masahiro Hotta (Tohoku U) Josh Kirklin (Perimeter) Max Lock (TU Vienna) Fabio Mele (U Western Ontario-Louisiana State U) Flavio Mercati (U Burgos) Takayuki Miyadera (Meiji Gakuin U) Markus Müller (IQOQI Vienna) Kasia Rejzner (York U) Robert Spekkens* (Perimeter) Wolfgang Wieland (FAU Erlangen) Edward Witten* (IAS Princeton). * online	Quantum Reference Frames 2025	OIST	Qubits & Spacetime Unit	2025-10-13
Zhuo-Yu Xian, Julius Maximilian U. of Würzburg & Free U. of Berlin	Aperiodic Chain from Discrete Holography	Online		2025-02-04
Juice Xu, UC Santa Barbara	Geometry and Algebra from Chords in Double-Scaled SYK	Online		2025-01-29
Krishna Jalan, The Institute of Mathematical Sciences, Chennai, India	Generalized second law for non-minimally coupled matter theories	OIST		2024-10-31
Andreas Blommaert, IAS	No-boundary observations	Online		2024
Stefano Baiguera, INFN Perugia, UCSC Brescia	Entanglement spectra from holography	Online		2024
Maria Knysh, VU Brussels	Black hole microstates and their applications	Online		2024
Victor Franken, Ecole Polytechnique, CPHT	Horizon causality from holographic scattering in de Sitter spacetime	Online		2024
Allie Sivaramakrishnan, Caltech	Proper Time Correlators in Field Theory and Gravity	Online		2024

Speaker Name(s)	Title	Location	Co-Organizers	Date
Renata Ferrero, FAU Erlangen	RG for relational observables	Online		2024
Upamanyu Moitra, U Amsterdam	Extremal Black Holes in AdS-CFT	Online		2024
David Kolchmeyer, MIT	Chaos and the emergence of the cosmological horizon	Online		2024