NEWSLETTER #2

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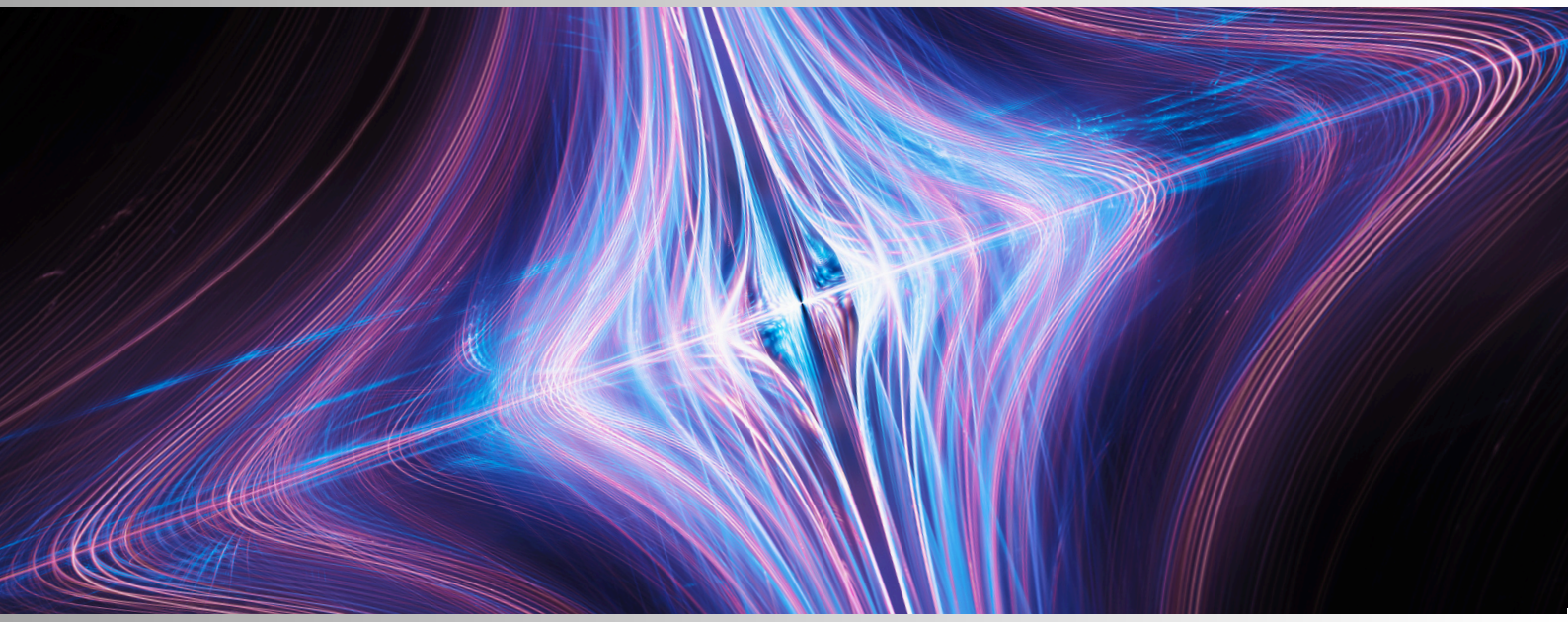
SPATIAL QUANTUM OPTICAL ANNEALER FOR SPIN HAMILTONIANS



Welcome to **Heisingberg** Newsletter!

Project

HEISINGBERG aims to bring our state-of-the-art spatial photonic spin simulator (an iterated cycle of all-optical processing through a spatial light modulator that couples 10,000 spins) into the quantum regime by upgrading its coherent drive to squeezed light, making it fully programmable through vector-matrix multiplication schemes, use of holography, ancillary spins and effective magnetic fields, and designing dedicated custom-tailored and purpose-built algorithms. This development will stimulate the quantum information processing community by concretely articulating problems of algorithmic complexity and clarify the nature of the quantum advantage available in annealers and simulators. These advances will allow us to demonstrate, on a cloud platform, annealing and adiabatic algorithms that can efficiently solve NP-hard problems.

Partners

UBITECH ubiquitous solutions

SAPIENZA UNIVERSITÀ DI ROMA

FORTH INSTITUTE OF ELECTRONIC STRUCTURE AND LASER

UBITECH quantum supremacy

CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

UNIVERSITY OF CAMBRIDGE

Funded by the European Union
GA No: 101114978.

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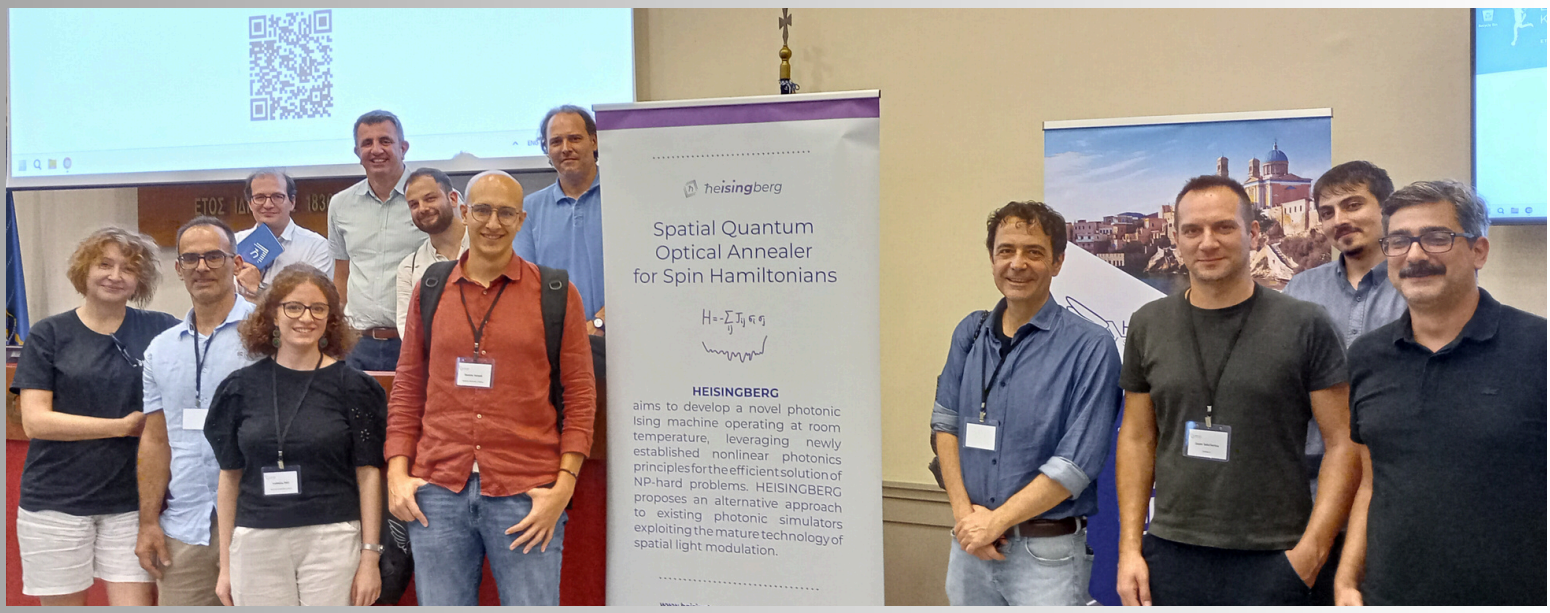
HEISINGBERG 2nd Plenary Meeting | Greece

The 2nd HEISINGBERG Plenary Meeting took place on October 4th, hosted at Cyclades Chamber of Commerce Hall, in Ermoupoli, Syros Greece. The meeting was organized by FORTH as a side event of the Hybrid Photonics and Materials International Conference, held from 30 September to 5 October 2024.



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Presentations at Hybrid Photonics and Materials Conference

1. **Fully Programmable Spatial Photonic Ising Machine by Focal Plane Division**, Daniele Veraldi, Sapienza University of Rome
2. **Photonic spin glasses: from fundamentals to combinatorial optimization and machine learning**, Claudio Conti, Sapienza University of Rome
3. **Spatio-temporal correlations of polaritons**, Fabrice Laussy, Instituto de Ciencia de Materiales de Madrid (CSIC)
4. **Simulating Ising Models with Spatially Modulated Light**, Jason Sakellariou, Qubitech
5. **Observation of a 2D soliton gas in a quantum fluid of light**, Ludovica Dieli, Sapienza University of Rome

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Publications

1. Riccardo Falcone and Claudio Conti
Localization in quantum field theory, Reviews in Physics **12**, 100095 (2024)

2. Jason Sakellariou, Alexis Askitopoulos, Georgios Pastras, Symeon I Tsintzos
Encoding arbitrary Ising Hamiltonians on Spatial Photonic Ising, arXiv:2407.09161

3. Richard Zhipeng Wang, James S. Cummins, Marvin Syed, Nikita Stroev, George Pastras, Jason Sakellariou, Symeon Tsintzos, Alexis Askitopoulos, Daniele Veraldi, Marcello Calvanese Strinati, Silvia Gentilini, Davide Pierangeli, Claudio Conti, Natalia G. Berloff, Efficient Computation Using Spatial-Photonic Ising Machines: Utilizing Low-Rank and Circulant Matrix Constraints, arXiv:2406.01400

4. Airat Kamaletdinov, Natalia G. Berloff, Coupling Light with Matter for Identifying Dominant Subnetworks, arXiv:2405.17296

5. James S. Cummins, Natalia G. Berloff, Vector Ising Spin Annealer for Minimizing Ising Hamiltonians, arXiv:2403.16608

6. Marvin Syed, Kirill P. Kalinin, Natalia G. Berloff, Engineering, Computer Science
Beyond Digital: harnessing analog hardware for machine learning, Corpus ID: 273642119

7. James S. Cummins, Hayder Salman, Natalia G. Berloff, Classical vs Quantum annealing and manifold reduction in soft-spin minimizers of Ising Hamiltonians, arXiv:2311.17359

8. Nikita Stroev, Natalia G. Berloff, Nir Davidson, Benchmarking the optimization optical machines with the planted solutions, arXiv:2311.06859

9. Eduardo Zubizarreta Casalengua, Fabrice P. Laussy
Spatial correlations of vortex quantum states, arXiv:2402.01627

10. Eduardo Zubizarreta Casalengua, Elena del Valle, Fabrice P. Laussy
Photon liquefaction in time, APL Quantum **1**, 026117 (2024)

11. J. Barrat, A. F. Tzortzakakis, M. Niu, X. Zhou, G.G. Paschos, D. Petrosyan, P.G. Savvidis
Qubit Analog with Polariton Superfluid in an Annular Trap, Sci. Adv. **10**, eado4042 (2024)

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Event Highlights

International Day of Light
Daniele Veraldi, Ludovica Dieli, SAP
16/05/2024 Rome, Italy

18/05/2024 Rome, Italy
European Researchers' Night
Claudio Conti, Daniele Veraldi, Ludovica Dieli, SAP

20th ETSF Young Researchers' Meeting
Daniele Veraldi, SAP
30/05/2024 Toulouse, France

06/06/2024 Mexico City, Mexico
ETIC Tlahuilli Polariton School
Fabrice P. Laussy, CSIC

Workshop on Coherent Ising Machines
Symeon Tsintzos, Qubitech
04/07/2024 Nicosia, Cyprus

04-05/07/2024 Garching, Munich, Germany
Multiphotonics
Fabrice P. Laussy, CSIC

Machine Learning Photonics Summer School Lake Como School of Advanced Studies
Claudio Conti, Daniele Veraldi, SAP
2-6/09/2024 Como, Italy

9-13/09/2024 Naples, Italy
EOSAM 2024 - European Optical Society Annual Meeting
Claudio Conti, SAP

Invited Talk At the Progress in Physics, Institute of Physics Meeting
Natalia Berloff, CAM
9-10/10/2024 London, UK

15-16/10/2024
Egmond aan Zee, Netherlands
Keynote Talk at the 47th NNV AMO annual meeting of the Atomic, Molecular, and Optical Physics division of the Dutch Physics Society
Natalia Berloff, CAM

Invited Seminar the Max Planck Institute for Dynamics and Self-Organization
Natalia Berloff, CAM
23/10/2024 Göttingen,Germany

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Fact Sheet

Title: **Spatial Quantum Optical Annealer for Spin Hamiltonians**

Acronym: HEISINGBERG

GA No: 101114978

Start: 01 November 2023

End: 31 October 2027

Budget: € 3.260.250 €

EU Fund: € 3.260.250 €

Topic: HORIZON-EIC-2022-PATHFINDERCHALLENGES-01-06

Scheme: HORIZON-EIC Grants

Call: EIC Pathfinder Challenge: Alternative approaches to Quantum Information, Processing, Communication, and Sensing

$$H = -\sum_{ij} J_{ij}\,\sigma_i\,\sigma_j$$

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